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Castings Aid in Handling Large Ore Shipments

SINCE ancient times when man first dug metals from the earth and adapted them to various uses, iron has been a gage of increasing civilization. As the human race has progressed so has the use of iron ore increased until today, in the most advanced period of world history, millions of tons are consumed annually. The greatest ore mines in the United States are located in the Lake Superior region where lake transportation is available to get the ore to market. Since the lake shipping season is of only 7 to 7½ months duration, enormous tonnages must be handled in a relatively short time. If it was not for the modern handling equipment used at Great Lakes ports, difficulty would be encountered in unloading huge tonnages from the great bulk freighters. However, the ingenuity of man has conquered that obstacle by the invention of the ore unloader. The distinctive features of the machine are the walking beam with its stiff leg at the front end, the huge bucket, and the practically continuous use of the bucket in digging. The foundry industry plays an important part in the construction of those machines, contributing driving machinery, bucket parts, wheels, gears, shaft couplings, bearings, etc. Several divisions of that industry have contributed to the construction of the monsters.

Iron Ore Unloaders, Which Are Found at Many Lake Ports, Contain Numerous Castings

Find Where Castings Can Be Sold

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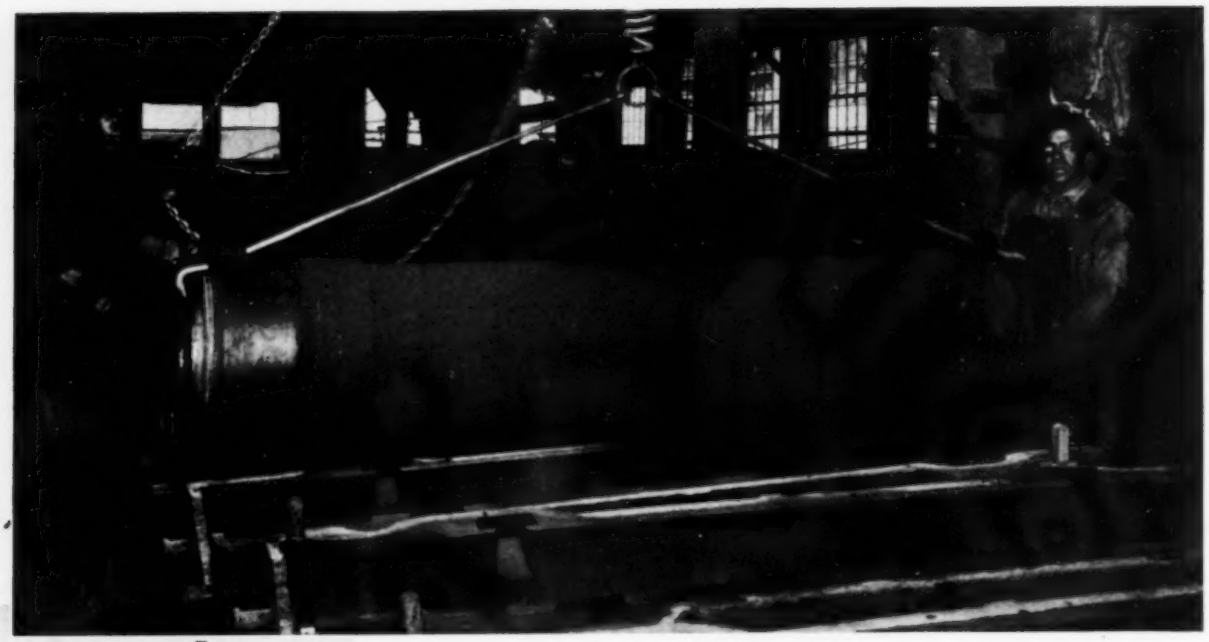


Fig. 1—Machined Ends of Arbor Rest in Green Sand Prints of the Mold. Fig. 2—(Left below)—Installing a 20-Inch Main

Casts Pipe With Universal Joints

By Pat Dwyer

SECTIONS or lengths of cast iron pipe are joined to each other according to any one of four widely practiced methods. Each method has its proponents and opponents and each method has its advantages and disadvantages when compared with the others. Local conditions and other circumstances usually constitute the determining factors in the selection of one type of pipe in preference to others.

In one style of cast iron pipe, the joint is effected by inserting the straight spigot end of one section into the bell end of another section and then sealing the space between the two iron surfaces with lead. In a second type of joint the pipes are provided with flanges at the ends. These flanges are faced in a machine and a circle of bolt holes is drilled. Flanges on two sections are brought together and held in place by a row of bolts. A third type of joint known as a flexible joint is formed by machining the spigot end into the arc of a sphere and forming the bell end with a core to correspond. The space between the bell and spigot ends is filled with lead in the usual manner, but the spherical shape of the spigot end, allows the entire length of pipe to shift position to a certain extent without affecting the tightness of the joint.

Several stages in the molding of pipe with the fourth type of joint, an iron to iron joint made at the Bessemer, Ala., plant of the Central Foundry Co.—are shown in the accompanying illustrations. This company with headquarters in New York, operates pipe, radiator and boiler foundries in Bessemer, Holt and Anniston, Ala., Vincennes, Ind., Baltimore, Lansdale, Pa., and Newark, N. J., and a coal mine, coke oven and blast furnace industry at Holt, Ala.

Since its introduction about 30 years ago it is claimed that this type of pipe has found wide application in water supply, fire protection systems and gas lines and practically every field where cast iron pipe is employed. It is subjected to all the tests and must meet all the specifications of pressure pipe made by any

other of the various methods.

For example, the allowable variation in thickness above or below the standard thickness shown in the accompanying table shall not exceed 0.04-inch in pipe from 4 inches to 16 inches diameter. No standard length of pipe shall weigh less than the standard weight by more than 2.00 per cent for class No. 150, nor by more than 4.00 per cent for class No. 250 as shown in the same table. The pipes are molded and cast horizontally in green sand, but they are not shaken out until they have lost all color of heat. This precaution is observed to prevent unequal contraction. Cast iron flasks are employed throughout, therefore the castings may be left in the sand as long as may be deemed necessary. Manifestly the time varies, since the range of sizes of pipes varies from the smallest, 2 inches diameter, to the largest, 30 inches diameter.

Fig. 3 (Below) — Several Pieces of Equipment Are Pressed into Service To Place the Core in the Mold

Fig. 4 (Left)—The Wedges in the Handles Prevent the Chain from Slipping. Fig. 5 (Above)—The Cope Is Rolled Back on Hinges

The test bar taken from each heat differs from the American Foundrymens association arbitration test bar, 1.20 inches diameter, 18 inches in length and broken on supports 12 inches apart, in that it is rectangular 1 x 2 inches and 26 inches in length. This bar when placed flat upon supports 24 inches apart and loaded on the center must support a load of 2400 pounds and show a deflection of not less than 0.34-inch before breaking.

All these pipes are made in standard 6-foot lengths and afterward the ends are machined for an iron to iron joint. The machined joints are slightly tapered to provide for deflection and are concentric to each other when the joints are made up. This type of joint provides for laying the pipe out of line and for contraction, expansion and deflection of the pipe after installation without leakage. The machined surfaces of the joint are brought together properly by bolts inserted in the lugs on the ends of the pipes. It is claimed that 6-foot lengths affords maximum economy in handling and laying.

With a considerable feeling of pride the com-

pany points to an episode a few years ago in the history of Bessemer, Ala., where a record was established in laying pipe lines. Through the sudden failure of a spring the city's supply of water was cut off and connection had to be effected immediately with the water system of the neighboring city of Birmingham.

Thursday morning the spring went dry and Thursday night the first relief line, 3000 feet of 8-inch pipe had been trucked 6 miles, laid and connected. Decision to lay 12,000 feet of a 12-inch line was arrived at by midnight Thursday. Friday morning the work of trucking 500 tons of pipe to a destination 6 miles away was commenced. By 6:00 p.m., Sunday, or in 50 working hours—real working hours—Bessemer was taking water through this new line. On Monday a decision was reached to lay a booster line, 5000 feet of 14-inch pipe. Monday at 5:00 p.m., the first of 250 tons was loaded on trucks for delivery 8 miles away. The entire consignment was delivered in 11 hours. The line was connected and ready for service in 12½ working hours, by 9:00 a.m., Tuesday. It was tested at 110 pounds pressure and showed no leakage.

Obviously only a large plant with a great stock on hand could handle an emergency order of that kind with ease and dispatch. The Central Foundry Company's plant at Bessemer, Ala., has a weekly capacity of 650 tons of pressure pipe and fittings. The metal is melted in two cupolas each with a melting speed of 18 tons per hour. These are operated from 3 to 4 hours per day according to the requirements.

All work is on a piece work basis, to the extent that a definite number of molds, depending on the size, constitutes a day's work. When this assigned task is done the men go home. This method obtains through all the pipe foundries in the South and is based to a considerable extent on the fact that the negro worker likes it and will work harder under this method than under any other.

Desire for more leisure time in the afternoon and evening, induces the men to begin work at daylight in summer and before daylight in the winter. On special occasions with a whole afternoon of sport and pleasure in prospect, the day's work has been completed by noon. A somewhat popular conception—based like many conceptions on incomplete data—to the effect that colored workmen are lazy and inefficient, is partly right and partly wrong. Also, and this too, is contrary to a general belief, the workmen are not all alike, any more than all men of any other color are all alike.

The indictment may be true to the extent that the colored molder likes to play, to lay off for a day or a week for no apparent reason, to spend his pay as rapidly and as spectacularly as possible. Usually the greater part of the pay has been drawn in advance, but the fact remains that while he is on the job, his batting average for speed and agility is equalled by few and probably surpassed by none in the foundry league, and this includes the automobile and stoveplate foundries.

Practically without exception, metal patterns are employed for all the molds made in this plant. This applies to both sections of the foundry, that part of the floor devoted to the production of standard straight lengths, and the division where the fittings and connections are made. Obviously no wooden patterns could withstand the severe usage to which these iron patterns are subjected day in and day out for years.

The pattern is machined accurately to size and the surface is finished perfectly smooth to prevent the sand from adhering and to impart a smooth face to the mold. Since the two halves of the mold are symmetrical, a single pattern serves for both cope and drag. A typical pattern mounted and ready to receive the flask is shown in Fig. 8. Lugs for bolting the pipe sections together are located on the parting line of the pattern. Two additional lugs, top and bottom, are placed on the large sizes and on some of the smaller sizes destined for heavy duty. The cores for forming the bolt holes in these lugs are larger in diameter than the bolts, to permit, if necessary, deflection of the assembled sections from a straight line.

Sand in all the molds is rammed by hand. The pattern is mounted at a height above the floor to facilitate this operation. Naturally the height varies with the diameter of the pipe and the size of the flask employed. The pattern is mounted on a cast iron box surmounted by a closely fitting machined plate which serves as a stripping plate. A lever on the outside of the box controls a toggle arrangement on the inside by which the pattern is pulled down approximately 1-inch before the half mold is lifted off. By changing the stripping

Figs. 6 and 7—Cast Iron Flasks Are Formed to Special Shapes To Reduce the Amount of Sand and Molding Time to a Minimum. A Single Core Serves for Two Castings

plates, various sizes of pipes may be molded at any of the ramming stations.

Shoulders on the stripping plate engage the rectangular guide pins bolted to the sides of the flask and thus locate it accurately in place. Two pins are bolted to the drag on one side and two pins are bolted on the opposite side to the cope. With this arrangement, every pipe on the floor lies in the same relative position. Also it is impossible for a careless or hurried workman to place a cope end for end on a drag. This arrangement also facilitates pouring the metal. The molds are placed close to each other to conserve floor space and are poured at one end through gates formed in the core print.

Two monorail lines serve each floor. A hoist suspended from one is utilized for lifting the flasks, molds and cores. Wood bottom boards are employed and these are manipulated by hand. The second monorail is located above the gangway. It forms part of a general system that extends with switches into all parts of the foundry, including the space in front of the cupolas. Ladles suspended from this monorail convey molten iron to the various floors.

Ram By Hand

Sides on the heavy cast iron pipe flasks are tapered to reduce the amount of sand required to a minimum. This formation also dispenses with the necessity of providing bars either in the copes or drags. Sand strips on the joint side of the flask hold the arch of sand in place after the drag has been lifted from the pattern and before the drag is rolled over and placed on the bottom board. The same of course is true of the cope, which only is rolled over at

Fig. 8—Heavy Cast Iron Flasks Conforming Closely to the Shape of the Pipe and Equipped with Pins Near the Ends on One Side Yield Long and Satisfactory Service

rare intervals. Usually it is lifted from the pattern and placed directly on a cored drag. The tapered sides hold the sand in place when subjected to the pressure of the molten iron.

Sand is shoveled into the flask by hand and is rammed also with the shovel handle. The upper course is leveled off with a butt rammer. A nice degree of skill, gained only through actual experience, is required to ram the sand to the proper density. If it is rammed too hard the iron will not lie against it quietly and the resulting casting will be scrapped as *rough, dirty, scabby, cold-shut or blistered.*

If the sand is not rammed hard enough, it will yield under the pressure and weight of the molten iron and the casting will be condemned as swollen and over weight.

Pipe Specifications

Nominal Inside Diameter Inches	Class (Working Pressure)	Approx. Thickness Inches	Approx. Pounds Foot	Weight per Length
4	150	0.31	16	96
	250	0.37	18	108
6	150	0.33	25	150
	250	0.43	30	180
8	150	0.37	36¾	220
	250	0.47	44¼	265½
10	150	0.41	49¼	295
	250	0.50	60½	363
12	150	0.45	64¼	385
	250	0.53	75½	453
14	150	0.475	82	492
	250	0.565	94½	567
16	150	0.51	101	606
	250	0.60	115½	693

Fig. 8—Pattern Is Mounted on a Stripper Plate Through Which It Sinks Before the Half Mold Is Removed

Spring Absorbs Shock

Hand operated chain hoists are employed extensively throughout the plant and various appliances have been devised for attaching the loads. Several of these devices may be noted in the accompanying illustrations. The beam for lifting the flasks, shown in Fig. 8 has been in use for many years and apparently will last indefinitely. A piece of steel strap bent over each end and bolted in place supports a small cast iron sheave wheel. In practice a short endless chain is thrown over each sheave with the lower end engaging the trunnions on the end of the flask. With the load suspended in the air, it is rolled comparatively easily in this manner. The chain moves with the load.

The coil spring shown in part in Fig. 1 represents one of the clever, spontaneous ideas by which workmen on any long running job, lighten the burden, shorten the time or increase the production. It serves as an insurance against any jerk or jump that might cause sand to fall from the core. The thickness of green sand swept on the core barrel is held merely by cohesion and consequently the cores must be handled without shock, jar or vibration. The coil spring between the hook on the

hoist and the link connecting the hooks attached to the core arbor, serves as a highly effective shock absorber.

The combination rig shown in Fig. 3 readily may be applied to a wide variety of cores. Two leather straps are adjusted on the main part of the core at the proper distance apart to support and balance it. This distance is decided arbitrarily by the molder. His facility is based on experience and in time develops into a kind of unerring instinct. A length of steel bar engages the straps at the top and the bar in turn is supported in the hooks of a ladle bail suspended from the crane hook.

Hooks on the ends of a light chain enable the molder to adjust the length to hold the branch of the T core in a horizontal plane with the main body. The upper end of the chain is looped over the crane hook and the lower end is looped around a short rod inserted in the exposed end of a reinforcing pipe in the lower half of the dry sand core.

A simple rig for rolling a cope is shown in Fig. 4. A short length of chain with a link at one end and a hook at the other end is attached to the loop handles in the cope. The crane hook automatically slips to the center when the weight is taken up. A wood wedge in each handle prevents the chain from *jumping* during the rolling process.

Employ Simple Rig

The acme of simplicity is illustrated in Fig. 7, a hook, a bar and two leather straps employed for placing a single dry sand core in two bell and spigot pipe connection molds. Many of the special fittings are molded in pairs in this manner to conserve sand and floor space and to avoid the use of chaplets. Each core half counteracts the tendency of the other half to rise under the influence of the molten metal in the mold.

Cores for the regular 6-foot pipe lengths are formed of green sand swept on cast iron barrels as shown in Fig. 1. The barrel is placed horizontally in a modified turning lathe where the sand is applied through gravity and cohesion. The sand falls through the narrow, elongated nozzle of a hopper, on to the rapidly revolving barrel. In a few seconds the barrel is covered with sand to the required thickness. The superfluous sand is removed and the desired shape and diameter are imparted to the core by a suitable strike mounted on a frame in a manner to engage the core at a line on the circumference midway between the top and the bottom.

The barrel is machined to a definite diameter for a distance of 4 to 8 inches at each end depending on the size of the core. This machined area corresponds to the core print, on a core made in any other manner. It rests directly on the green sand core print in the drag and is engaged by the corresponding core print in the cope. The edge of the semicircular opening in the drag or in the cope flask, does not touch the arbor. A small wedge is driven between the top of the print on the core barrel and the top of the arch in the flask end, after the mold has been closed and clamped. This prevents any movement of the core and insures an even thickness of metal in the casting after it has been poured.

White molders assisted by colored helpers are employed in the section of the foundry devoted to the production of miscellaneous pipe fittings. In practically all the repetition work, colored molders are employed, but nearly all the castings in what may be termed the general jobbing class are turned out by white men. The cores are dry sand. Outside the special shape flasks, the equipment, methods and process do not differ in any material degree from those found in the ordinary general jobbing gray iron foundry.

Recalls Pioneer Days on the Pacific Coast

By P. D. Forbes

THE accompanying illustration from a photograph of Smith Bros. Iron Works employes, Portland, Oreg., taken in 1877 is believed to be one of the oldest, if not the oldest picture in existence of foundry employes on the Pacific coast. The young man third from right in bottom row is Rube Straus, still foreman patternmaker for the company now known as Smith-Valley Iron Works. A merger was formed with Valley Iron Works, Appleton, Wis., a few years ago. The Smith brothers in the back row bear a remarkable family likeness to each other, even to the prominent watch chains.

They were mechanics of unusual ability, and established their foundry in the sixties in the brick building shown, formerly the Oregon state penitentiary.

The foreman molder, Bill Morgan, appears at extreme right, and just behind him with his hand on his shoulder is John Laseward, then a man around 50, patternmaker, draftsman and engineer. He was a man of rare engineering talent whose advice was much sought in the seventies. The man second from end front row at right is Robert Collier, one of the early day patternmakers on the Pacific coast. He arrived in San Francisco from Scotland in 1869 and began to work for Smith Bros., in 1870. For many years he was general superintendent, secretary and part owner. As the years rolled on the company built up a large and lucrative business supplying the growing western lumber industry with a special line of logging machinery of every description.

During the war the firm built many vessels and employed over 6000 men in the shipyard. Besides logging machinery, the company at present makes a special line of paper making machinery. The plant has occupied the same location for almost 75 years, a few blocks south from Portland's business section. This was well out of the crowd in the sixties when Portland's population was less than 10,000. In today's Portland with over 300,000 population, buildings of every description have been erected all around the plant, making the property quite valuable. S. Smith, son of one of the founders, is active head of firm.

A Group of Employes at Smith Bros. Iron Works, Portland, Ore. in 1877

Preventing Unsoundness *in* Bronzes and Red Brass

Part IV

ONE of the earlier investigations on influence of furnace atmospheres on a practical scale is that of Wolf and Burr, *Transactions*, American Institute of Metals, 1915. They say: "Our experience shows that with a neutral atmosphere, or one containing a slight excess of carbon monoxide, not more than 1 per cent being necessary, no oxidation of the molten metal occurred, and this without the necessity of covering the metal with charcoal, coke, glass, or other agents to prevent oxidation, the molten metal retaining its mirror-like surface."

Slag Is Formed

It is well known that with actual oxidation a slag covering is formed. On the other hand it is not so well known that a high percentage of carbon monoxide in an electric furnace causes formation of a dry scum, whereas any furnace melting clean metal with a neutral or approximately neutral atmosphere gives the clear mirror-like surface referred to by Wolf and Burr.

Somewhat later Woyski and Boeck, *Transactions*, American Institute of Mining and Metallurgical Engineers, 1923, attacked the then nearly universal oxidation theory calling attention to the occurrence of incipient shrinkage due to excesses of reducing gases. They conclude: "Gas and shrinkage cause porous metal and intercrystalline fissures. Oxidation gassing and shrinkage produce similar effects. Metal that has been subjected to bad melting practice, whether oxidized or gassed may be brought back to normal conditions by proper furnace practice. In case of gassed metal, a strongly oxidizing furnace atmosphere of a relatively high temperature, so as to produce quick melting will correct the gassed condition. The most important cause of gassed metal is the atmosphere of the furnace. We believe that an oxidizing condition in the furnace is less troublesome than one that is reducing, providing that the metal is protected by a thin layer of mineral flux; also that it is more economical in time and fuel."

Atmosphere Important

INFORMATION obtained by a number of investigators indicates that much of the difficulty encountered from porosity in nonferrous alloys may be due to the type of atmosphere maintained in the furnace. Consequently foundrymen should observe their melting practice carefully and see that neutral or slightly oxidizing atmospheres are employed. Data showing the effect of furnace atmosphere, effects of oxidation, and laboratory researches on the composition of gases contained in bronze and red brass are included in this article which is the fourth of a series. The third appeared in the Oct. 15 issue of THE FOUNDRY.

Shrinkage Theory Advanced

Bolton and Weigand, *Transactions*, American Institute of Mining and Metallurgical Engineers, 1929, in advancing the incipient shrinkage theory to cover the general phenomena of intercrystalline porosity, supply a large amount of quantitative data, confirming the observations of Woyski and Boeck, and indicating the effects of atmospheric conditions in open flame gas, crucible, and indirect arc electric furnaces. Most of their published work is confined to the alloy containing 88 per cent copper, 6 per cent tin, 4 per cent zinc, and 2 per cent lead, which was made up with a large percentage of virgin copper, tin, lead and zinc. By careful analysis of finished castings the

Table IV

Composition of Gases in Copper

(Gas heated for half an hour in the apparatus before removing)

Nature of metal	Sand Cast* Mersey	Chill Cast* Mersey	Sand Cast* Mersey	Sand Cast** Cathode	
Pouring temperature	2552° Fahr.	2552° Fahr.	2237° Fahr.	2245° Fahr.	2543° Fahr.
Sulphur dioxide and hydrogen sulphide	.....	.....	4.64	10.25	2.00
Carbon dioxide	5.79	7.57	9.30	10.01	4.50
Carbon monoxide	41.43	32.38	19.80	20.62	25.20
Hydrogen	40.98	50.19	56.72	52.89	56.95
Saturated hydrocarbons	1.97	0.93	1.14	1.00	3.05
Unsaturated hydrocarbons	0.88	1.51	1.19	0.60	0.75
Oxygen	1.22	.....	0.87	0.89	.....
Residual gas, nitrogen	7.83	7.42	6.32	3.98	7.55
Cubic centimeters of gas collected per 100 grams at 32 deg. Fahr. and 29.92 in. Hg.	3.65	2.88	4.08	2.66	3.53

*None of these were cast at the same time.
**These were poured from the same pot with about 5 minutes interval.

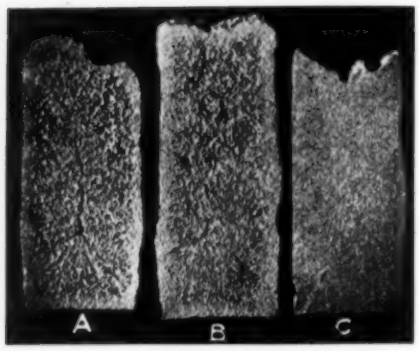


Fig. 25—Three Conditions of Red Brass Caused by Furnace Conditions

metal was shown to contain only traces of usual impurities. Their findings on gas furnace practice are as follows: "The gas furnace was studied first. The fuel used was mixed natural and artificial gas of the following average composition: Ethane, 13.55 per cent; methane, 57.60 per cent; carbon monoxide, 11.53 per cent; hydrogen, 12.73 per cent; nitrogen 2.60 per cent (by difference); carbon dioxide, 1.90 per cent, and oxygen, trace.

Many Castings Made

"In spite of the fact that regular operating methods melted the metal free from excessive dross, it was feared that improper mixing of the gases in the burners allowed oxidation, therefore some 100,000 test castings were made, over a period of several months, with a furnace atmosphere of the following average composition: Carbon dioxide, 3.96 per cent.; oxygen, 1.20 per cent and carbon monoxide, 6.78 per cent.

"This gave what the foundrymen term a *long* flame and resulted in a rapid increase in porosity. It was evident that while the old practice was not ideal, increase in carbon monoxide and other reducing gases made things bad. It was obvious that the burners and arrangement of air and gas were improper. Better mixing burners were substituted with the following average result: Carbon dioxide, 11.8 per cent.; oxygen, 0.4 per cent, and carbon monoxide, 0.9 per cent. More nearly neutral atmospheres effected radical increase in soundness in castings from these furnaces.

"Meanwhile records of the indirect-arc furnace were being analyzed. Shortly after installation of this furnace porosity began to mount. The ladles (dried and preheated) often boiled violently. This was particularly noticeable when charcoal was placed on the bottom—an action which from later experience we believe is analogous to the action of sand thrown into aircharged water. It was deemed desirable to produce a more neutral atmosphere in this furnace before working on gating and pouring temperatures. First of all, the bricks were left out of the spout. This made little change in atmospheric composition. Then other means were taken to produce a neutral atmosphere. Gas analyses are taken twice daily. The following average monthly analysis is typical of present practice: Carbon dioxide, 16.9 per cent; carbon monoxide, 0.6 per cent, and oxygen, 0.5 per cent."

In commenting on this paper Boeck mentions burning of the gases rejected from gates of unsound castings. In a later discussion with St. John, Bolton asks what causes the boiling of ladles if not dissolved gases in silicon-free metal melted under reducing (carbon monoxide) atmospheres, and if not reducing gases what are the gases Boeck managed to burn. At that time Graham and Meisse, *Transactions*, American Foundrymen's association, 1930, showed that deep etching tests indicate that neutral atmospheres produce the most sound bronze, and differentiates between the effects produced by oxidizing and reducing atmospheres as shown in Fig. 25. *A* in Fig. 25 shows interior fissures resulting from a reducing condition. *B* shows the presence of oxidation, and *C* reveals a uniform structure which was obtained with a neutral atmosphere. St. John while not refuting the evidence given points out that different alloys probably are susceptible in different degrees to the furnace atmospheres.

Practical results are the criterion of the value and truth of research and theory respectively. Bolton and Weigand for example by applying research to large scale production work, reduced the porosity percentage on a selected group of particularly difficult castings from about 2.9 to 0.2 per cent, over a 2-year period. Further, the average strength of the alloy was raised from 35,000 to 40,000 pounds per square inch tensile in a short period, and the next year an average tensile of 42,180 pounds per square inch was obtained. This is higher than the maximum on admiralty gun metal reported by Daniels in the *Foundry Trade Journal*, April 3, 1930. On the latter alloy, using virgin metals and neutral atmosphere, Bolton and Weigand obtained slightly over 49,800 pounds per square inch tensile using a test bar of dimensions quite like that of Daniels. (Tensile strength is a good criterion of incipient shrinkage, the two being in inverse ratio).

Oxidation Occurs

Others have obtained similar opinions and beneficial results from work on a practical scale. Dews, *Foundry Trade Journal*, March 7, 1929, points out: "Another explanation of the peculiar appearance of the fracture of a porous casting is that the metal is oxidized. But why should the oxidized metal be confined, as these bad places generally are, to a local area of the section? If the metal is oxidized, surely the oxide tints should permeate the whole section. Sometimes they do, but generally the discolored area is only local. To avoid this so-called oxidation, one is recommended not to stew the bronze, but to melt it rapidly and to use a deoxidizer. All these remedies will, under certain circumstances, help in producing sound castings, but their effect is not due to avoidance of oxidation. For instance, slow melting is supposed to produce oxidized

Table V

Variation in Gas Composition

(Gas Removed from the Apparatus as Quickly as Possible)

Nature of copper	Cathode	Cathode	Mersey	Mersey
Pouring temperature	2543° Fahr.	2245° Fahr.	2552° Fahr.	2259° Fahr.
Sulphur dioxide and hydrogen sulphide	8.65	15.95	15.55	27.60
Carbon	15.35	9.20	3.40	6.60
Carbon monoxide	21.05	21.60	57.00	41.60
Hydrogen	23.95	31.40	7.60	.....
Saturated hydrocarbons	3.30	3.85	2.95	.....
Unsaturated hydrocarbons	2.05	2.60	2.45	2.10
Oxygen	0.90	0.75	1.05	0.40
Residual gas, nitrogen	24.75	14.65	9.40	21.70
Cubic centimeters of gas collected per 100 grams metal at 32 deg. Fahr. and 29.92 in. Hg.	.....	1.0	2.33	1.9

metal. Now, in actual practice, to get rapid melting in the ordinary bronze foundry, working with natural-draft coke furnaces, the draft pressure must be high and the furnace atmosphere must be oxidizing. As a matter of fact, there is plenty of experimental evidence that an oxidizing atmosphere is essential to produce good-quality bronze. At least, one well-known foundryman has put on record that, where an oxidizing atmosphere could not be secured in the furnace, sound castings could not be made unless an oxidizing agent was added to the alloy just before casting. He found that, when bronze was melted under reducing conditions, the addition of lead oxide was necessary to induce soundness.

"Now, in bronze there is an entirely different condition. There are no soluble oxides in the alloy. It can be shown that tin and zinc both reduce copper oxide. In the making of bronze therefore, copper oxide is reduced, and in its place zinc or tin oxide is formed. These oxides are both insoluble in bronze. Zinc oxide is not only insoluble, but it is not even wetted by the alloy. Moreover, it is light, and it quickly rises to the surface of the melt, where it may be skimmed off. It is only when proper precautions are not observed in skimming and pouring that zinc oxide will be found in the castings.

Inclusions Appear as Patches

"These oxide inclusions are readily apparent without the aid of a microscope, and appear as patches of greenish-white sandy material or sometimes looking like a bit of paper which has been screwed up and thrust into the metal. Apart from the unsightliness of such patches of oxide on the machined surface of a casting, it must be remembered that the oxides are of low mechanical strength, and therefore they break up the continuity of the metal and lower its strength. Oxide inclusions also may impede the liquid flow during the freezing and contraction of the casting, and thus lead to porosity.

"The elimination of tin oxide is not so easy as it is to free the bronze from zinc oxide, because the tin oxide is nearly as heavy as the metal, and therefore does not readily rise to the surface of the melt, but remains disseminated throughout as insoluble particles. Frequent comment has been passed on the fact that phosphorus, the most popular dioxidizer for bronze, will not reduce tin oxide. As phosphorus usually is added only to the extent of about 0.02 per cent, it is difficult to see how it can be expected to react with any oxide distributed, as is the tin oxide in the form of fine insoluble particles. A much larger proportion of any reducing metal would be required to react under these conditions.

"It is the author's considered opinion that arguments which seek to blame the cause of porosity in bronze castings on to oxides, gas occlusions, improper mixing or similar secondary matters without full reference to the volume change on freezing and the freezing range are likely to be misleading; and that these two latter effects are of supreme importance.

"There seems to have been a general avoidance in the past of any discussion of such a point of view, and on account of this remission there is at present a disappointing paucity of important fundamental data thereon, but if foundrymen were to develop a more sympathetic attitude toward research and a greater freedom in discussing their troubles, there is little doubt that research could quickly be guided into channels of profitable incidence on practice."

Table VI

Effect of Furnace Atmosphere

No.	Density Gr./c.c.	Percentage Unsound	Tensile lb./sq. in.	Elong. Per Cent	Fire Condition
KC2*	8.110	8.9	.....	.....	Reducing
KF2	8.751	1.45	44,150	28.5	Oxidizing
KJ1	8.507	4.20	34,380	20.0	Partially
KJ2	8.501	4.27	36,620	20.0	Oxidizing
KK1	8.669	2.04	40,630	20.0	Partially Oxidizing
KK2	8.739	1.62	13,970	13.0	Half previous charge presolidified
KL1	8.748	1.49	.....	.....	Oxidizing
KL2	8.771	1.23	.....	.....	Oxidizing

*Contained 90 per cent copper and 10 per cent tin.
All specimens cast at 2102 degrees Fahr.

While Daniels' investigation, *Foundry Trade Journal*, April 3, 1930, is directed principally toward the actual solubilities of various gases in bronze, it is significant that his highest percentage of unsoundness is found in metal melted under reducing atmospheres.

Because of slow melting, excessive metal loss and heavy slags, melters do not have to be told to avoid highly oxidizing atmospheres. When molten copper is exposed to a highly oxidizing atmosphere, cuprous oxide is formed. In bronzes and red brasses the other metals oxidize before the copper. Zinc will even remove the oxide from molten copper.

Bolton and Weigand made up a mix of virgin metals, melted it and poured into ingot and test bars. They then remelted the alloy twice in an oxidizing atmosphere. The original alloy contained 87.14 per cent copper; 5.72 per cent tin; 4.87 per cent zinc, and 2.07 per cent lead. The tensile strength was 41,750 pounds per square inch, the elongation 44.4 per cent and the elastic limit 17,500 pounds per square inch.

On the second remelting the alloy contained 90.48 per cent copper; 5.78 per cent tin; 1.33 per cent zinc and 2.21 per cent lead. The tensile strength was reduced to 32,145 pounds per square inch. The metal was sluggish and even at 2200 degrees Fahr. did not pour castings satisfactorily. The metal was poor and showed red brown spots like those in gassed metal. Thus excessive oxidation produces bad results, incipient shrinkage, just as gassing, impurities, wrong pouring temperature and impurities do.

The first extensive investigation of the actual nature of the gases contained in sound bronze was that by Carpenter and Elam, *Journal*, Institute of Metals (London), 1918. From careful study of the data presented it is evident that all melting was done under reducing conditions and that soundness (or the opposite) depended upon catching the proper balance in pouring temperature. Thus the study is one of bronze melted under approximately the same furnace conditions, hence the results cannot be expected to indicate the phenomena which are encountered under various melting conditions. If reducing gases are absorbable they should be found in both the sound and unsound metal under conditions of their experiments. Bearing that in mind the following excepts are presented:

"The most unsound ingot was that poured at the highest temperature, and was made from fire-refined copper. Of those made from cathode copper, that poured at the highest temperature was also unsound but had not risen in the mold to the same extent as the former. Both those cast at 2255 degrees Fahr. and 2237 degrees Fahr. respectively were perfectly sound, and those poured at 2075 degrees Fahr. were good. This emphasizes the fact that it is easy to get unsoundness by pouring at a high temperature, but it is not so easy to err on the other side and get unsoundness due to pouring at too low a temperature. The blowholes were bright almost without exception, indicating that the atmosphere was *reducing*, not oxidizing. Practically every variety of copper was tried with the same results. Also it

appeared immaterial whether the melting was carried out in a coke or gas furnace.

"Provided the metal is allowed to cool in the crucible, however much it may have been overheated, it is obtained quite free from blowholes. This applies to an alloy made for the first time or to previously cast metal which is remelted. This is to be expected, or sound castings would be unobtainable. By alternately pouring from about 2552 degrees Fahr. and allowing to cool in the crucible, the same metal is rendered alternately unsound and sound. The actual casting operation, therefore, provided the temperature is sufficiently high, is the deciding factor in producing porous metal.

"It is a generally accepted fact that blowholes are caused directly by the evolution of dissolved or trapped gas during the solidification range, and in the case of copper or its alloys this gas is generally considered to be oxygen. Steam from the sand may account for those holes on the outside of the mold, but cannot be responsible for all. It was decided that the most suitable way of determining the cause and possible prevention of porous castings was to investigate the gas or gases which are actually dissolved and trapped in the metal.

Gases Are Analyzed

"Guichard attempted to solve the problem by a somewhat different method. He heated pure electrolytic copper in the form of blocks and wire in vacuo, and analyzed the gases evolved. He only heated the metal to 1112 degrees Fahr. and found that the volume of gas obtained depended considerably on the surface exposed; 100 grams of copper wire gave off 6.56 cubic centimeters of which 62 per cent was carbon dioxide and 38 per cent hydrogen and nitrogen, between which he did not distinguish.

"Guellemin and Delachanal, *Comptus Rendus*, 1910, estimated the volume and composition of the gas obtained by heating certain alloys of copper and tin in vacuo. The pieces were taken from sound and unsound forgings, and the gas consisted of hydrogen, carbon dioxide, and carbon monoxide. The sound forgings gave off 90 per cent hydrogen, while the unsound gave larger proportion of carbon monoxide and carbon dioxide. It was thought that by comparing the volume and composition of the gases in sound and unsound castings, any differences between them might give a clue to the problem. To do this, sections cut from the castings were melted in vacuo, and the gases given off collected and analyzed.

"The gas did not always all come off on the first heat, and sometimes two or even three melts were necessary before on further heating there was no change in pressure. A chill casting was an interesting example of this. The metal was heated until no further gas came off. On examining it after cooling, it had the appearance of an unsound sand casting, the surface had risen and it was full of large blowholes. On heating further more gas came off. Trials were made of a silica boat for holding the metal, but this had to be discarded as bubbles of gas collected between the boat and the under surface of the metal and remained there. The gas could not force its way out even at the reduced pressure, and the character of the solidified metal showed where these bubbles had been. This demonstrates that the gas does not readily escape from the metal. The gas began to come off at about 842 degrees Fahr. from a sand-casting; that from a chill casting at about 1382 degrees Fahr.

Differences Are Slight

"The most constant characteristic of all these gas samples is the large percentage of hydrogen. Allowing for errors in the analyses owing to the small volumes of the gases —seldom more than 3 or 4 cubic centimeters and sometimes less—and for variations in the experiments for differences in the preparation of the castings, etc., there is no outstanding difference between the gases collected from sound and unsound castings which would account for the absence of blowholes on the one hand, and the presence of blowholes on the other hand. The gas that shows the greatest variations is carbon monoxide, but there is nothing to indicate that it has any relation to the unsoundness. Taking everything into consideration, it cannot be concluded that there is any gas present in the metal poured too hot that is not in the sound metal, nor does it appear that there is a larger volume of any one gas or gases present in the one than in the other. Tables IV and V present some data on gases in copper obtained under different conditions. The large volume of hydrogen may be due to the dissociation of water formed by the combustion of hydrocarbons, with a simultaneous formation of carbon monoxide and carbon dioxide."

From the results obtained from their investigation Carpenter and Elam conclude: "The best casting temperature for admiralty bronze is about 2192 degrees Fahr. Overheating to 2552 degrees Fahr. and pouring at that temperature is certain to produce porous castings. Pouring below 2012 degrees Fahr. often produces unsoundness. The nature of the copper appears to have little or no influence on the final results. Metal melted and cooled in the crucible is sound, even if it has been overheated to 2552 degrees Fahr. This also applied to previously cast unsound metal. The blowholes are formed by the liberation on cooling of gases dissolved in the metal.

"The gas collected by heating pieces of castings in vacuo is of a complex nature, consisting of the typical furnace gases. Its volume and composition vary with the method of collection, depending on the time the gas remains in the furnace. The two types are: (a) The gas is removed quickly. In this case it has a small volume. There is little hydrogen and generally a fair proportion of sulphur dioxide and hydrogen sulphide. (b) The gas is heated to constant volume or removed only slowly. In this case the volume is much larger. There is a large percentage of hydrogen—about 50 per cent.—and the sulphur dioxide and hydrogen sulphide are either very low or entirely absent.

"The zinc is largely responsible for this change, as there is much less difference in the gases collected in the two ways from pure furnace-refined copper. It may act in two ways: (a) It may lower the solubility of these gases in the alloy. (b) By volatilizing in vacuo it reacts with the sulphur forming zinc sulphide, and this condenses on the inside of the tube. A gas of approximately the same composition is found in both sound and unsound sand castings and in chill castings. There is not a constant or sufficient difference in the volume of gas obtained from unsound and sound castings to account for the presence of blowholes in the one and their absence from the other.

Present as Oxides

"It does not seem likely that the blowholes are formed by the liberation of oxygen as all the oxygen present in the metal is in the form of oxides of zinc, tin or copper, if there is much present, the first two of which are stable compounds and not at all likely to decompose when once formed. The analysis of the gas obtained by heating pure copper resembles that of the gas obtained from a copper-tin alloy, and this suggests that the gases which cause unsoundness in the alloy are actually in the copper itself. The volumes of these gases are also about the same. When once the gases are in the metal it is very difficult to extract them. The most suitable practical way of avoiding porous castings would appear to be to determine the temperature of the alloy so as to insure that it is poured within the range 2318 to 2102 degrees Fahr."

As can be seen Carpenter and Elam, melting under reducing conditions found reducing gases in both sound and unsound metal. By the expedient of varying pouring temperatures they determined a range in which solidification was sufficiently rapid to prevent rejection of gases, yet where the metal still retained

(*Concluded on Page* 54)

CARBON IS CONTROLLED

In Synthetic Gray Iron

By Edwin Bremer

OFTEN a careful study of existing plant conditions leads to changes which may result in reducing the labor cost of manufacturing processes the betterment of the product without increasing the cost, the saving of raw materials or the profitable reclamation of a material which formerly was disposed of as scrap. Some time ago Robbins & Myers Inc., Springfield, O., manufacturers of electric motors and other electrical equipment, were confronted with a problem of disposing of a considerable quantity of thin sheet scrap which resulted from stamping out the laminations used in motor armatures, etc. Since sheet scrap is bulky, a baling press was installed to place it in a more salable form.

Scrap Is Sold

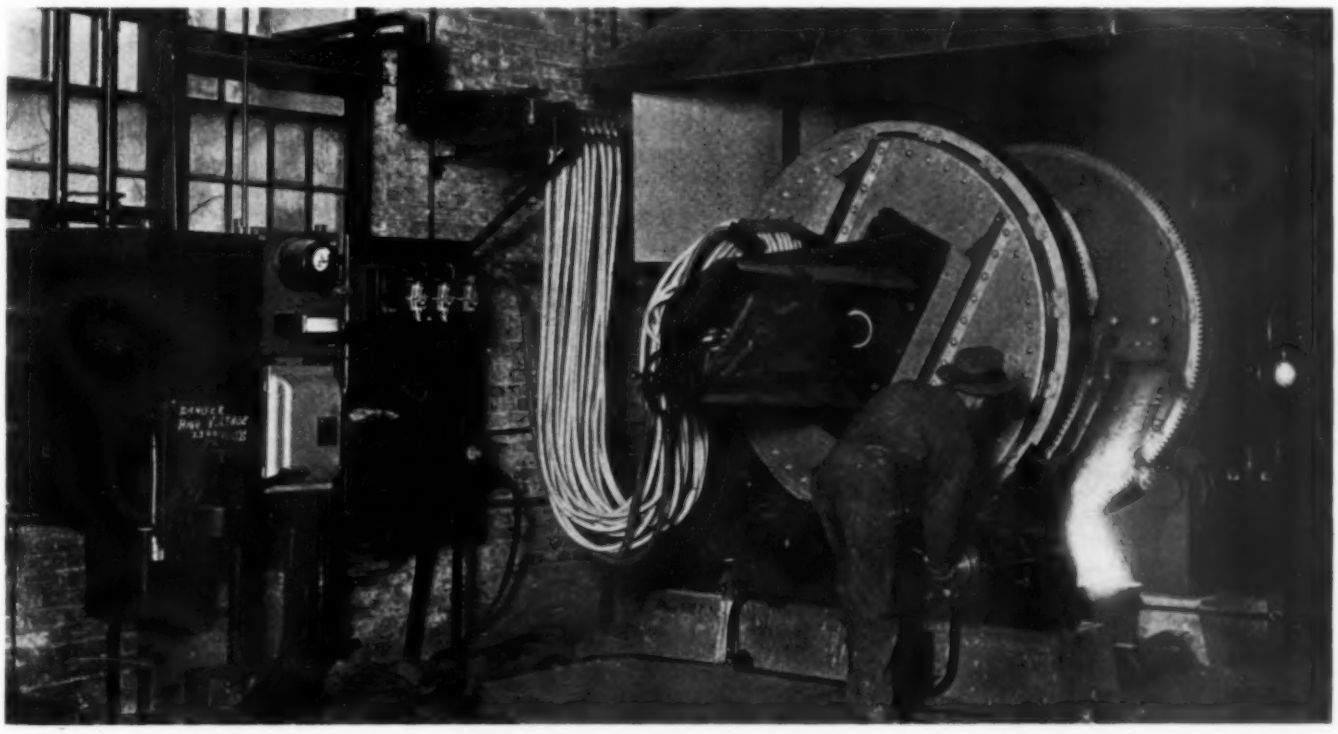
Some of the bales, which weigh approximately 200 pounds each, were used in the firm's cupola for the production of semisteel castings. However, only a small amount of the baled scrap could be used in that manner, and in the major portion was sold as scrap. Those methods of disposal of the scrap operated fairly well until the firm began to manufacture a large quantity of small radio transformers in which the cores were made from laminations of high silicon sheet steel. The silicon steel contained about 3 to 4 per cent silicon, and for that reason the regular purchasers of the baled soft steel scrap did not want it.

Consequently, that type of steel scrap was a drug on the market, and had to be stored on the firm's premises. As it began to accumulate, ways and means were sought to use it in the cupola charges in the foundry. It was found that the silicon steel scrap could be used, but not efficiently as considerable silicon was lost in the melting process. Therefore, attention was turned to other methods of melting. After investigating different types of furnaces, it was decided to try the indirect-arc, rocking type electric furnace, and after considerable experimental work at the furnace manufacturer's plant, that type furnace was installed in the Robbins & Meyers' foundry. Since the firm already had a heavy load demand on the power company's lines, the addition of the electric furnace to the power load made but slight difference in demand cost.

The furnace installed has a capacity of 1 ton, and was supplied by the Detroit Electric Furnace Co., Detroit. Raw materials used at first were high silicon steel scrap, soft steel scrap, return foundry scrap, and petroleum coke. After the high silicon scrap no longer was available, as at present, the proper silicon content was obtained by the addition of ferrosilicon. The baled scrap is hoisted to the door level by a ¼-ton electric hoist which is mounted on a jib crane. At the door level, the bale is placed on a peel and pushed to the back of the furnace. The bales are distributed evenly across the furnace by directing the peel to the proper point.

Carbon Is Absorbed

Petroleum coke is added with the charge in a definite proportion to the weight of the charge. Extensive experiments have shown that the absorption of carbon by the molten metal involves the length of time



A 1-ton Rocking Type Electric Furnace Is Used with Charges Composed of Baled Sheet Steel Scrap, Ferrosilicon and Petroleum Coke

the two are allowed to react and the weight of coke added. Since the melting time is 1 hour and 40 minutes for a ton of metal, the amount of carbon absorbed can be regulated by the weight of coke added. For example tests carried out with high silicon steel as the base metal showed the following carbon pickup:

Coke Added Per Cent	Carbon in Iron Per Cent
3.96	3.050
4.69	3.299
4.72	3.350
4.86	3.354
5.21	3.410
5.25	3.456
5.26	3.425
5.70	3.601

From those values a curve was drawn which indicated the percentage of petroleum coke necessary to give a carbon content within the range of 3.0 to 3.6 per cent. Similar investigations were carried out on the charges now used, and any desired carbon content may be obtained.

After the day's heats are tapped the furnace is charged, sealed, and allowed to stand without any power load over night. However, in those hold-over charges, no petroleum coke is added until the power is turned on the next morning. It has been found that the pick-up of carbon during the long interval is so great as to make the iron kishy. Power for melting is 725 kilowatt-hours per ton, and 4 heats are melted per day. The furnace lining is patched once a week.

Carbon and silicon in the resulting iron may be varied to meet any desired range for producing castings from those with a white fracture to those classed as extremely soft gray iron. The silicon usually ranges from 2.0 to 3.50 per cent and the carbon from 2.5 to 3.5 per cent. One typical soft gray iron containing 3.25 per cent silicon; 0.035 per cent sulphur; 0.29 per cent manganese; 0.060 per cent phosphorus, and 3.35 per cent total carbon gave a transverse strength of 2900 pounds, a deflection of 0.19-inch, and had a brinell hardness of 163. These tests were determined on a specimen 1¼-inch diameter and 15 inches long broken on 12-inch centers.

Another specimen lower in silicon showed a tensile strength of 40,000 pounds per square inch determined on pieces ¾-inch in diameter and 2 inches long which were machined from the regular arbitration test bar 1¼-inches in diameter and 15 inches long. The brinell hardness measured at the center of the cross section of the arbitration bar was 202. To differentiate the electric furnace, synthetic gray iron that the firm produces, from ordinary gray iron, the trade name *Aremite* has been adopted. Since the major portion of the special gray iron is used in various products such as the frames for electric hoists, gear cases for electric trolley cranes, etc., manufactured by the firm, advertisements published by Robbins & Myers Inc. place special emphasis on the fact that the material used has exceptional qualities.

Cylinder Mold Is Jolted on a Machine

WHERE foundrymen have installed jolt molding machines without following the instructions of the manufacturer, trouble almost invariably has been experienced. In practically all cases a full set of instructions for setting up and operating the machine is supplied by the manufacturer. These instructions are based on long experience and when they are disregarded the purchaser only has himself to blame if the results are not satisfactory.

In one instance, the foundation of timber and concrete was so inadequate that draughtsmen in an adjoining building complained that they could not draw a continuous line when the jolter was in operation in the foundry. In other instances the machine is loaded beyond its working capacity and imposes a wrecking strain on a foundation designed for normal working conditions. In all cases where jolting machines are mounted and operated properly, they give eminent satisfaction.

Occasionally in the beginning, some difficulty has been experienced in having the sand pack properly in pockets and corners. Usually it has been found that the fault lies with the sand and not with the machine. Sand for use on a molding machine should be what is known as free flowing. While hand ramming a sand may have more bond, be a little finer, may vary a little in homogenity and moisture content, sand for a molding machine must be selected and prepared with care. The more intricate the design of the pattern, the greater the care to be observed in the selection and preparation of the sand.

The greatest satisfaction is derived from sand with uniform sized grains, partly rounded and showing a maximum strength with a minimum amount of bond.

Illustration shows a gas engine cylinder 18 x 30 inches and weighing 6000 pounds that was molded on a jolt machine from a split pattern. After the mold was finished the small cores were set in the drag followed by the lower half of the jacket core and then the main core through the center. The upper half of the jacket core then was adjusted in place and secured as well as a few small cores in the cope. Most of the fin shown at the joint of the jacket core is removed in the machining operation. The vents in the jacket core are brought to the center and provision made for their escape through suitable openings in the mold.

Casting Molded from a Split Pattern on a Jolt Machine

In making up mixtures for cylinders, allowance must be made for whether the cylinder is to operate in a vertical or in a horizontal position. The action of the piston and packing rings is more severe in a horizontal engine than in the vertical type. The weight of the piston is a considerable factor in the wear of the cylinder. In the casting shown in the illustration a satisfactory iron conformed to the following analysis: Silicon 1.50 per cent, sulphur 0.10 per cent, phosphorus 0.45 per cent, and manganese 0.80 per cent.

To Standardize Fittings

The American Society of Mechanical Engineers in co-operation with the American Standards association, Heating and Piping Contractors' National association, and the Manufacturers' Standardization Society of Valve and Fittings Industry recently published a tentative draft of a proposed standard for pipe plugs of cast iron, malleable cast iron, cast steel or forged steel which gives the dimensions, threads, etc.

American Monorail Co., Cleveland, has opened a new office at 7338 Woodward Avenue, Detroit, in charge of S. J. Woodworth.

A FOUNDRY BUDGET Directs *Operating* and *Sales* EFFORTS

By A. K. Reading

MANY different conceptions of a budget are found in daily domestic and industrial applications. Most of them are meaningless and their application results in only a flare up of momentary enthusiasm which might better be devoted to a more worthy effort. The author believes that the word budget means something which may be used as a guide, a mark to shoot at, in preference to a hard and fast financial program which must be followed no matter what new and changing conditions arise.

It further is assumed one who prepares a budget does not aim to make a name for himself as having a most excellent insight into the future. Rather he is one who sets his total sales higher than he can reasonably expect from his business, and likewise sets his costs less than be believes can be attained. In striving to meet these ideal conditions the true worth of a budget will appear in benefit to the stockholders, satisfaction to the executive, and stimulation to the operators.

Faces Problems

The fall of 1927 found the author in a maze of difficulties and uncertainties. Faced with a highly fluctuating market, both in price structure and in volume, it seemed almost impossible to control and overcome the shop inertia to meet market variations. The spirit was willing but many of the cost records were but accurate history, and poor working tools. No department or group of operations stood out prominently in need of corrective measures, and nowhere could a controlling hand be placed to insure profits. Corrective efforts could not be made because it was not known where to start or where to go. It was suggested that a form of budget might be the proper and most convenient means of providing the desired control of sales and operations. At first thought the idea seemed to be wholly impracticable, but on more careful consideration, all difficulties smoothed themselves away and progress was started on a budget for 1928.

The first presupposition of a successful budget is that there is or should be a profit above the cost of doing business. Therefore the assumed selling price must be greater than the cost of operations. Right there lay the first great physiological benefit of the budget, because attention was called to the fact that no matter what the annual business might be, if the ratio of cost to selling as budgeted was maintained, a profit was assured no matter what the sales might be. The author believes that a budget is wholly justified, if for no other reason than the one given.

When work was started on the budget in November, 1927, it was felt that 2500 tons would be sold in 1928 at a price of $145 per ton. This could be produced at $135 per ton. In line with the spirit of budgeting, the year's tonnage was set at 3000 with a sales price of $150. The cost of doing business was depressed to $130 per ton, leaving a spread of $20 per ton for profit. These figures at that time appeared unattainable and wholly fantastical.

The spread of $20 per ton was to be the profit. How was this new profit consciousness to be applied? The monthly cost summary of the Steel Founders' society supplied the necessary machinery. There, ready for use, was an ideal setup. On one hand, properly subdivided, were those items of cost for which the superintendent was responsible. On the other hand, were those items for which the executive and his board of directors alone were responsible. In the first case, a budget would stimulate the efficiency and the genius of the superintendent and his staff. In the second case, business volume is the dominating characteristic and is influenced only through executive channels. The budget would place the responsibilty of sales and management squarely up to the executive and his superintendent. The society cost summary became the foundation of our budget without a change in any item.

The predetermined cost price was to be $130 per ton. This was broken down so that the superintendent had to do his work for $83.20 per ton or 64 per cent of the cost, while the general expense would have to be held to $46.80 or 36 per cent of the cost. These costs and their percentages were again broken up, somewhat arbitrarily, into dollars per ton and per cent of total cost for every item listed on the Steel Founders' society standard cost summary.

Costs Are Set

The program called for 250 tons per month for both production and selling. Therefore, it became a simple matter to allot to each item of cost or expense, just the amount which should be spent in a month to carry on the program. Figures were prepared for January, then for January and February, then for January, February and March, and so on until the twelve consecutive months were covered and the budget was complete. It was proposed at the end of every month to insert behind the divisions of the budget, the actual cost of each particular item from the beginning of January, as well as the actual percentage of total cost per ton for that item. Some of the departmental budget percentages which were experimentally set down are given in the following:

Division	Per cent
Metals	11.84
Conversion	17.87
Direct labor	9.36
Molding Indirect Expense	11.39
Core Dept. Indirect Expense	2.90
Cleaning Indirect Expense	7.93
Annealing Indirect Expense	2.71

The first three months of 1928 passed, then things began to happen. It became apparent that our hopes of

Gives Experience

THE author speaks from experience in describing, in a reminiscent manner, some of the effects resulting from the use of a budget in a steel foundry. His remarks apply with equal force to any other type of foundry. The idea of a budget, as presented, is not a hard and fast financial program, but rather a goal for directing the efforts of the organization. The results of the installation of such a system are given, and the elements of cost in their relationship to each other are discussed. The writer, A. K. Reading, is general manager of the Zimmerman Steel Co., Bettendorf, Iowa. This article is abstracted from a paper presented before the Steel Founders' Society of America at the meeting in Cleveland, May 14, 1930.

securing $150 per ton for sales could not be realized. The drying up of a local source of scrap shot the metals percentage up to 17 per cent of the cost instead of 11.84 per cent as budgeted. Under the nonbudget operations, these things probably would have been accepted as just another series of those irritants which keep the foundrymen from leading a dull life.

However, with the budget, the picture stood out with surprising clearness. We had expected to get a $20-spread between sales and cost, but after 3 months we were not getting the $20 and it didn't look as though we would at the end of the year. The budget showed the fault and indicated those cost items which were contributing to the delinquency. The remedy, of course, was to keep our $20-spread no matter what the sales price might be or what we had to pay for scrap.

We had thought our $130 per ton cost of doing business was good practice, but now under stress of necessity, everyone in the organization commenced to dig into all conceivable angles of the budget so that our total cost might be lowered. New equipment was added and better methods of manufacturing put in effect, methods about which we had always talked but never installed.

Budget Has Effect

Results of this activity were far reaching. We ended the year with tonnage sold greater than the budget. Our costs were diminished and a spread between our selling price and cost of doing business was obtained, not of $20 as budgeted, but of a much larger amount, all of which exceeded our wildest expectations. The cost per ton of $130 was lowered greatly, yet the items totaling 64 per cent in the budget, for which the superintendent was responsible, came out 64½ per cent, indicating a uniform effort toward reduced cost in each item of shop expenditure. The budget was directly responsible for the good results we obtained because, first, it pointed out an inherently dangerous condition of trade which ordinarily might have escaped notice; secondly, it pointed out where the remedy lay and the paths by which it might be reached.

It is not proposed here to outline or delve into the detailed functions to which a budget may be applied. The larger the institution, the farther the breaking down of budget cost percentages may be carried. Those favoring the bonus system of compensation can find a profitable means through the budget to reward where reward is due and censure where censure is due. A budget, if constructed as a co-operative friend and not as an inexorable tyrant, can develop a guiding influence, correcting many ills. It points to a department where savings can be made. During the first two months of 1929 our cleaning department expense was running 11.4 per cent of the total cost. It had been budgeted 9.9 per cent. The foreman was called in and his expenditure laid before him. He was shown that his department percentage was running higher than the budget because his supply account and his indirect labor percentages were swinging out of line. Probably for the first time in his life, that foreman was given a thorough and detailed picture of his department, not only in the offending items, but in all others. So completely did he grasp the idea, that by the end of May, that year, his indirect costs for the first 5 months were down to 9.8 per cent of the total production cost. He had made up his deficiency entirely and even gained a little in 2 months' time.

It is the intangible things like the above which have so thoroughly convinced the author of the great value of an operating budget. Its physiological effect on an organization is tremendous, and its possibilities unlimited. Our first attempts were made on cost per ton. Today, we combine this with a budget based on sales price, and we are of the opinion that ultimately the latter will be the only form used.

When all the figures are compiled at the end of the year, a great many interesting statistics appear. Many phases of shop operation show up in a much more important manner than they do if budgeting is not attempted. Others, which generally have been considered highly influential on costs, scarcely warrant the excessive attention that has been paid to them.

To illustrate, some of the percentages of total cost are given in the following table, with the reservation that they are the experience of one particular shop.

Division	Per cent
Metals	16.75
Conversion	16.65
Direct Labor	12.08
Molding Indirect Expense	10.50
Core, Indirect Expense	2.28
Cleaning, Indirect Expense	10.66
Annealing, Indirect Expense	2.45
Sand, Indirect Expense	1.70
Core Mixtures	0.90

Wisconsin Group Hears Committee Reports

Progress reports of the sand and test bar committees featured the regular monthly meeting of the Wisconsin Gray Iron Foundry group held Oct. 8 at the Schroeder hotel, Milwaukee. The work of the sand committee was outlined by M. S. Ariens, and Prof. Scott Mackay, University of Wisconsin, Madison, presented the report of the test bar committee. Prof. Mackay described the work on the test bar committee in comparing properties found in the standard A.S.T.M. test bar as compared with bars poured in a variety of other ways and with two sizes of the standard British test bars. Some interesting data have been obtained. Prof. R. S. McCaffery, University of Wisconsin, also talked on the subject of test bars, comparing French, German and American bars.

The group has been showing considerable interest in the work of the sand committee which is making a survey of the sands now being used successfully by members of the group. The work includes the determination of fineness, clay content, permeability, strength, etc. After the committee has secured the previously mentioned data, it will be matched with corresponding information on sands within a reasonable radius of the member plants.

Attendance at meetings of the group has increased considerably since the founding of the group and although meetings are held in Milwaukee many firms from other parts of the state are interested. The group contains 28 member firms of which 17 are from Milwaukee, 2 from Waukesha, and one each from Racine, Beloit, Port Washington, New Holstein, Green Bay, Oshkosh and Brillion, Wis., North Chicago and Chicago, Ill. Total attendance has increased from 211 in 1927 to 507 in the 1929-30 group year. Over 1400 foundrymen have attended meetings since the group was formed.

Preventing Unsoundness in Bronze and Brass

(*Concluded from Page* 50)

sufficient fluidity to fill the mold properly. However by the expedient of overheating the metal (2552 degrees Fahr.), allowing it to cool in the crucible (this is allowing time for escape of gases) and pouring at lower temperatures they obtained sound metal. That shows that if gases are present their bad influence can be eliminated wholly or in part, by thermomechanical treatment. Casting in a chill is one type—rapid cooling to prevent gas rejection. The other, allowing the gases to escape, is typified by the experiment where by holding the metal molten at a high temperature the gases are allowed to escape before casting.

The results of Carpenter and Elam on pouring temperatures merely confirms the work of many others, Karr and Rawdons excellent paper being a typical example. It is only along the lines of constructive criticism that the writer ventures to point out that none of these pouring temperature researches has or can get down to the fundamental causes underlying the phenomena of porosity. It is more important to remove the causes than to modify the effects.

Cleveland office of the American Manganese Steel Co., Chicago Heights, Ill., has been moved to Room 909, Midland Bank building.

Fundamentals of

FOUNDRY PRACTICE

Auxiliary Equipment and Method of Operating the Cupola Exert an Important Influence on the Castings

By Ivan Lamoureux

Interpreted in the Light of American Practice by Pat Dwyer

Part XXII

SOME foundry superintendents never succeed in calculating exactly the necessary quantity of iron to be charged. They estimate approximately the tonnage to be cast then check up the level of the last charge from time to time and thus estimate the quantity of metal available. If, in their estimation, sufficient metal is not in the cupola, one or two supplementary charges are added.

When the material in the cupola is exceptionally low, that is, when the last charge is down to just above the tuyeres, it is not advisable to add any more. The bed coke is partly burned away and extra coke is required for any additional iron. This increases the cost of melting the iron.

In a filled cupola the charges of metal become heated progressively by the blast as they descend. They thus arrive in the melting zone at a high temperature. If the cupola is charged when it is very low, the iron has no opportunity of becoming heated on the way down and requires considerable time to reach the melted state. An additional quantity of coke also is required, as stated previously.

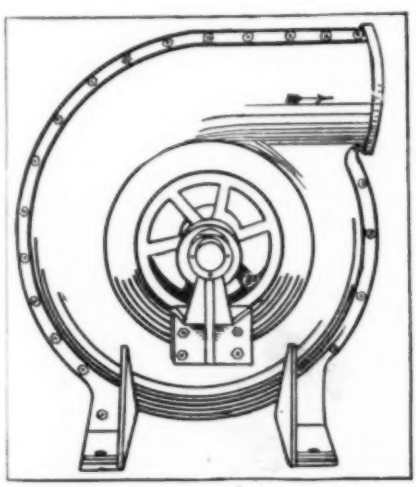


Fig. 273—Blower or Fan Used To Supply Air to Cupola

Melting the Iron

A COMPETENT foundry superintendent can estimate in advance the amount of iron required to pour all the molds on the floor. This estimate is one of the tests for his fitness for the position. An over estimate means excessive expense for handling and melting more metal than is required. An under estimate means that some of the molds on the floor must remain unpoured until the next time the cupola is made ready, thus taking up valuable floor space and probably deteriorating. Size and shape of the blast pipe leading to the tuyeres exert an important influence on the volume and pressure of the air entering the cupola. Straight pipes or those with wide sweeping curves are best. Under certain conditions a forehearth is a commendable addition to a cupola, but in the majority of instances it is not necessary. Proper precaution and careful operation during the melting period are the principal factors in holding the lining repair bill to a minimum.

With a little experience, one readily can determine when the cupola ceases to melt any further iron. No more smoke is visible and the flames escaping from the charging door or from the top of the stack become white. The blower becomes more noisy. By looking through the tuyeres it will be noticed that hardly any iron is dropping.

The blower should be shut off when melting stops, to prevent wearing away the lining of the cupola. Blowing air through the incandescent coke bed without any iron on top converts a cupola into an enormous blow-pipe having an extremely high temperature where the lining of the cupola wears rapidly. Therefore, it is preferable to leave a little iron in the cupola rather than keep the blast on until the last drop of iron is drawn out.

Ash from the coke, oil and dirt on the scrap iron, scale on some pieces, sand from the pig iron and scrap united with the limestone, form a rather fluid slag which floats to the surface of the iron bath. If left to accumulate for too long a time may float into the tuyeres. Furthermore it presses on the metal, raises the height of the bath and increases the difficulty of stopping the stream at the tap hole. Normally the first slag is tapped after one hour's operation, then every half-hour. The slag runs continuously from cupolas operating ly as iron and will run off as fast as formed.

Immediately after the iron has been tapped, the slag hole is opened by an iron bar and a bod is kept handy for stopping it. The iron rises little by little and raises the level of the slag, which runs off either on the ground or into a receptacle prepared for the purpose. The diameter of the slag hole should be twice as large as that of the tap-hole. Slag sometimes does not flow as freely as iron and will not run off as fast as formed.

As soon as the iron comes up to the slag hole level and a few drops run out, the slag hole is stopped by a bod obviously much larger than the one intended for the tap-hole. The tap-hole is immediately opened and a quantity of iron is removed

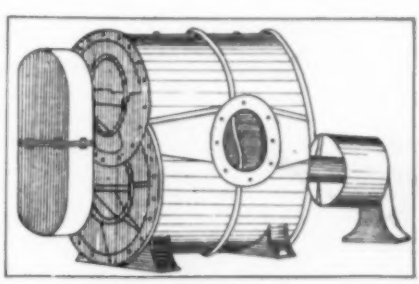


Fig. 274—This Blower Delivers Air at Positive Pressure

corresponding to the capacity of the crucible or well of the cupola.

The height of the slag hole above the sand bottom is determined by the class of castings handled by the foundry. Where only small castings are poured from small ladles, the slag hole should be placed but a slight distance above the bottom, otherwise at the moment of tapping a large quantity of iron in the well will render stopping difficult. Filling small ladles will be rather dangerous. Where large castings are poured with large capacity ladles, it is advisable to have a high slag hole and a crucible sufficiently large to hold a quantity of metal in proportion to the weight of the castings.

Forehearth Advantageous

A cupola equipped with a forehearth is advantageous when treating iron by reactive agents. Its use often is advisable when iron with a rather slight carbon content is desired. Where the melted iron goes immediately into the forehearth, it no longer is subjected to contact with the coke which gives it not only carbon but also sulphur. In ordinarily machine parts this is not of much importance, but the conditions are different where large proportions of steel are included in the melt. In the ordinary run of foundries the use of a forehearth entails additional upkeep and fuel expense.

A number of deplorable practices are in vogue in many foundries. They are not based on any sound premise. Some foundrymen fill the cupola with coke to the charging door before putting in the first charge of iron. Obviously this is a sheer waste of coke. Others start the blast as soon as the first charge of iron is put in. Some even start blowing before the cupola is well fired and thus obtain cold iron in the first few ladles.

Two types of blowers with essentially different principles of operation are employed in foundries. The centrifugal type blower is the older of the two. A centrifugal blower should be placed near the cupola, protected against the heat, flames, smoke and steam, but always connected with blast pipes of large radius in straight lines or at least with generous curves, wherever bends are necessary.

In this connection it is interesting to note that many prejudices still prevail. In some foundries the blower is placed underground. This is due to the conviction that the air will be fresher and that the efficiency of the cupola will be increased. In other foundries the blowers are placed near the roof with a duct coming down, under the impression that air flows down like water.

Overhead Ducts Best

General practice seems to indicate that overhead ducts are the best. They can be looked after better and are less likely to suffer accident. Cases are on record where founders broke iron over their blower ducts. The flying pieces struck the ducts and put the blower systems out of commission.

In the positive blowers, two vanes or impellors, generally in the form of a figure eight, rotate in a cylinder in such a way that all the air drawn in is compressed to the desired degree. To increase the pressure and still maintain the same diameter of outlet all that is necessary is to increase the speed. Thus it is possible to retain the same speed and reduce the size of the outlet to obtain a higher pressure. This type of blower delivers a definite volume of air at a definite pressure.

Blast pipes may be steel tubes joined by flanges. These readily follow the contractions and expansions of the cupola and vibrations of heavy machines that often are set on poor foundations. The founder may cast his own blast pipes and make them of a shape most suitable to his own requirements.

Pipe Diameter Is Larger

In practice, the diameter of the pipes is slightly larger than that of the fan outlet, to compensate for the slight losses in pressure. The further away the blower is located from the cupola, the larger should be the diameter of the pipes.

Fig. 275 shows a good installation. A straight duct *T* makes a direct connection between the blower *V* and the cupola *C*. Another satisfactory installation is shown in Fig. 276. Duct *T* is made with large sweeping bends.

Fig. 277 shows only a passable installation. Duct *T* has short bends. Fig. 278 shows a poor installation. The pipe *T* is made with a series of right-angled bends. Efficiency is low.

After the heat is finished, the cupola is cleaned. The firing door is opened after releasing the lock-

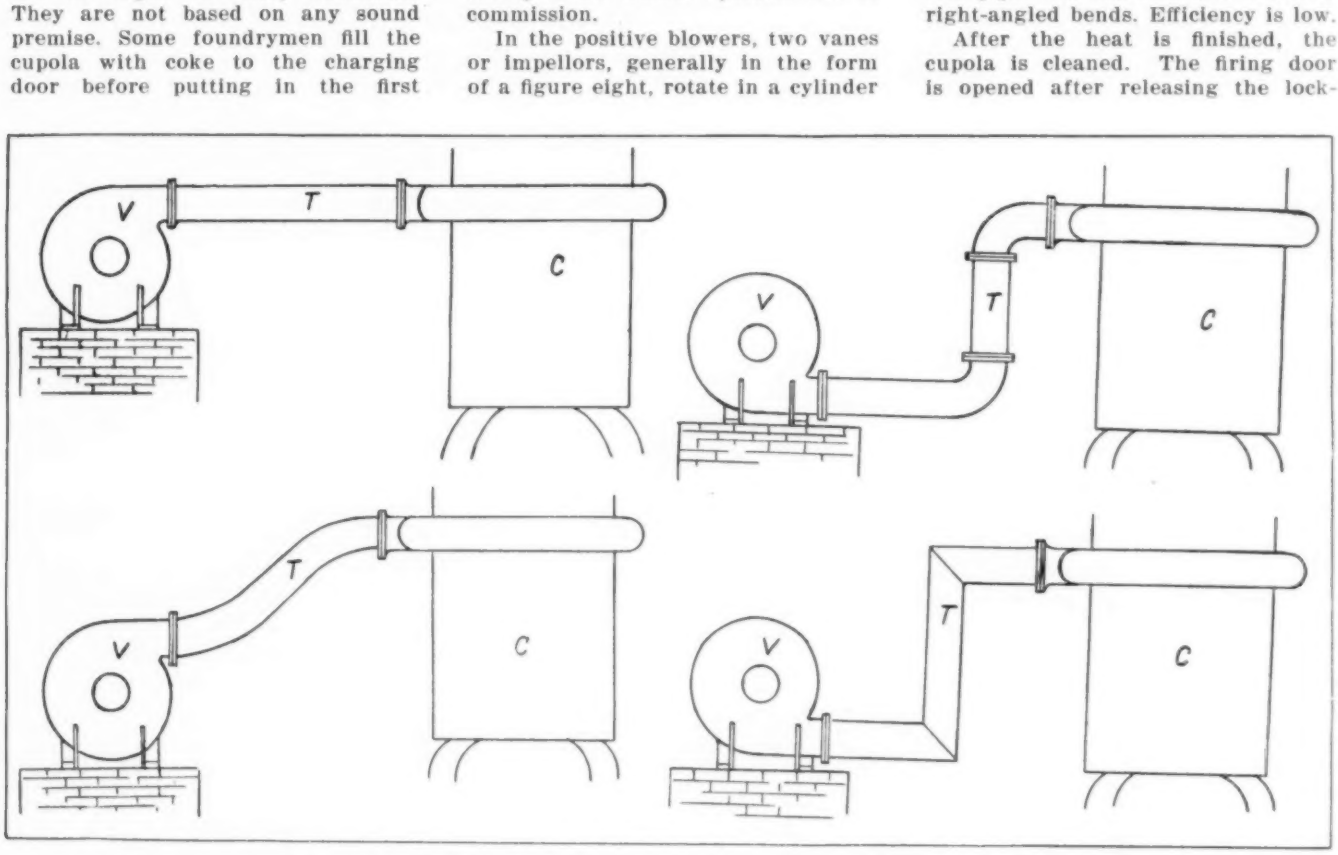


Fig. 275—(Left Above)—A Straight Blast Pipe Is Preferable To Any Other Shape. Fig. 276—(Left Below)—A long Sweeping Curve for Second Choice. Fig. 276—(Right Above)—Abrupt Elbows Impede the Flow of Air. Fig. 277—(Right Below)—Least Desirable of Any of the Shapes Shown

ing-bar. The safety latch is then released on the bottom door and the prop pulled out. This operation should be performed with the greatest care as some iron still might be lying on the bottom which on dropping would burn the workmen.

American cupolas have neither firing doors nor safety latches. The bottom door is held up by one, two or three props, depending on the size. Sometimes, particularly on small cupolas, a chunk of pig iron is thrown against the prop to knock it out. However, usually it is jerked out or pushed out with a long hook. A bottom made up with old sand will drop down almost at once, but if the sand is too fat the bottom will have to be forced open by introducing a long steel bar up from underneath.

In some cupola installations a flat iron frame is placed under the cupola to receive the hot coke and debris as shown in Fig. 279. The frame is connected by a cable or chain to a winch or a crane. As soon as the cupola has been dumped the frame is hauled out from underneath and the coke is cooled with water. Usually one of the cross bars in the frame is employed to trip the prop under the bottom door or doors. The residue now can be sorted comfortably. This is always a difficult operation when done under the cupola, especially if the same cupola is used every day. Also considerable time is saved in getting the cupola back in service again.

The coke is sprinkled with water until the fire is all out of it. The following morning the material is broken up with a pick to separate the coke from the cinders. If there is any reason to believe that iron is in the pile, it is all broken up with a sledge. A simpler and surer way is to put it through a drum screen. It is always good practice to pass the smaller stuff through the magnetic separator. In that way a lot of iron is recovered which otherwise would go out on the dump. Some founders favor the use of a wet mill for recovering iron from the drop.

To repair the cupola lining, the founder enters the cupola through the bottom. Standing on a short ladder he examines the walls and chips off with a hammer all the coke or cinder that may be sticking to the walls and tuyeres. He moistens the hollow spots carefully and fills in with fireclay. It is a good plan to pass this clay through a mill before using it. He finishes the job by smoothing the walls with a brush and clay wash.

Poor quality coke or coke charged in insufficient quantities, particularly with large pieces of iron, frequently cause a bridge in the cupola, and either stops or retards the melting. A sort of plug, composed of half-melted material obstructs further operation. Sometimes the condition becomes so serious that the bottom

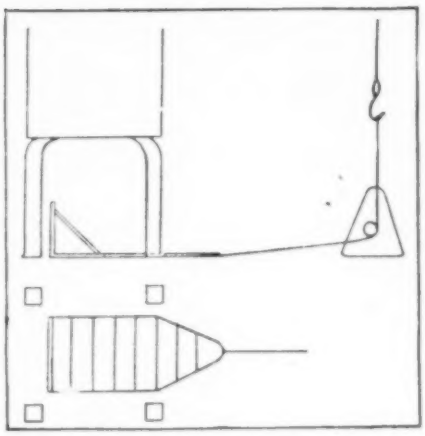


Fig. 279—A Cage or Frame Attached To the Crane To Pull the Drop

has to be dropped for the day and further attempt at melting abandoned.

Sometimes a bridge is formed at the end of the heat, due to keeping the blast on too long after all the iron is melted. The flame produced by the air passing through the incandescent coke destroys the lining which falls down into the cupola. Such a bridge is not serious. It can be forced down after the cupola has cooled by going in through the charging door and pushing it down with a steel bar.

Where no suitable melting equipment is available for heavy bronze castings, the metal may be melted in the cupola in almost the same manner as cast iron.

The cupola is blown empty for several minutes before charging the metal into it, to make the whole interior incandescent. The bronze charge is now put in, but in at least double the weight for iron. This precaution is observed to diminish oxidization as a result of the intimate contact of the metal with the fuel.

The ladles should be preheated to quite a high temperature to prevent the possibility of cooling the metal.

After a cupola has been used for melting bronze, it should not be used for melting iron without first taking proper precautions to clean out the traces of copper which may remain imbedded in the lining and which would render the first cast iron extremely hard and brittle. It is advisable to use the first heat after melting copper, for pouring ordinary castings, if serious trouble is to be avoided.

Readers Comment

Note—Material appearing under this head does not necessarily reflect the opinion of The Foundry or of its editors.

To the Editors:

On page 92 of the Oct. 1 issue of The Foundry one of the subscribers inquired about melting 40 tons of iron in 9 hours. The writer wishes to take exception to the answer given. Small cupolas have a tendency to bridge on long heats and the writer has experienced considerable difficulty in operating a 32-inch cupola. It is possible but not practical to run such a cupola at the rated capacity for 5 or 6-hours, but not much longer. This opinion is based on actual operating experience.

The 1 to 10 coke ratio is low for a long heat and the figure the writer always has used for the amount of air required is 153 cubic feet per pound of carbon. The amount of air then will depend upon the fixed carbon in the coke, and the coke to iron ratio. The coke bed should be 36 inches above the tuyeres instead of 30 inches. That will give a little higher melting zone with less danger of oxidized iron. The writer doubts whether a manufacturer of cupolas would guarantee or recommend a 32-inch cupola for melting 40 tons in 9 hours.

It would be a good deal better to get two cupolas lined down to 42 inches in diameter and use them on alternate days so that one may be repaired while the other is in operation. Another important consideration in melting small tonnages continuously is to have either a forehearth or reservoir ladle so that 1 or 2 tons of metal may be accumulated in the event that a large casting has to be poured.

David Tamor

Hartford, Conn.

Molds Chill Roll

To the Editors:

I was interested considerably in the query, "Chill Roll Cracking," and I would like to express what I consider is the fault with the complaint. You mention that filtration in the core makes a solid center which reacts against the contraction causing the roll to crack. You mention that the chill required is 2½ inches and that the silicon content is approximately 1.40 per cent. I have never known this silicon content to give anywhere near that chill depth. In good cupola practice 0.60 per cent silicon gives approximately 1½ inches chill and in reverberatory furnace work approximately 2 inches chill depth. In cupola practice of course, chill depth can be augmented greatly by oxidation or by the least

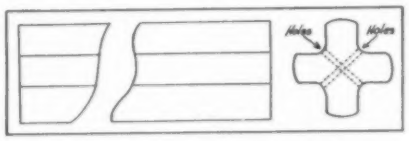
scaffolding, and in reverberatory furnace by oxidation. Roll cracking with a silicon content of approximately 1.40 per cent makes it more complicated to find the cause, whereas if the silicon content had been exceptionally low giving us a glassy white iron right through the casting it would enlighten us considerably. In a metal of this description contraction is great in all directions and if run particularly as you suggest from the top with so many small down runners on the outer side of the roll only aggravates the condition because hotter metal is obtained on the outside where contraction will be most and colder metal nearer the core where contraction is smallest. Also the metal which comes into contact with the chill in which the roll is cast, solidifies much sooner than the interior of the casting to a certain distance from the chill face. It would have made this question easier if it had been stated if the chill was hot or cold before the roll was cast. I have seen this difficulty of roll cracking overcome by getting the chills to a good black heat before casting, the rolls being cast through a spinning runner in the bottom neck. To feed these rolls the feeding rod is never submerged into the casting but the top of the head constantly is kept open and a little hot metal added occasionally. It is quite easy to see that if a chill roll is cast and the outside of the body of the roll is *pasty* or in other words beginning to *solidify* that plunging a feeding rod down below the casting neck quite easily will burst the face of the roll nearest the chill face.

Filtration of the core certainly will create a certain amount of tension when contraction is taking place but take for instance casting steel pinions with a densener or internal chill similar to the shape of the casting (pinions weighing as much as 10 tons). These do not crack yet we have a solid center to contract upon. The denseners used are hot before casting takes place, which naturally creates a certain amount of contraction in the densener. I just mention this point to show that it is quite possible to pour certain castings with solid interiors without trouble. In castings where mixtures are such that segregation can take place, casting at too high a temperature creates this trouble easily and is an important factor in obtaining good castings.

If as you suggest filtration in the core is the cause why use a barrel to build the core upon. The following sketch greatly overcomes this difficulty and is quite suitable for any kind of work and does not bend or twist as easily as barrels do.

A straight steel or wrought iron bar has 4 grooves cut as shown in the accompanying sketch. These bars can be slightly tapered and when in use the bigger and thicker end is placed in the print of the mold. Small staggered holes can be drilled through these bars to insert wood or iron pegs as needed to hold the core material when upright. A shackle could be used to put core into position. When commencing to make a core on these core bars, insert first of all 4 round rods along the length of the bars to make vents. To hold these rods lap around with wire in about 4 places. Then bind with hemp or screw bands and proceed as usual after placing either wood or iron pegs to hold the core material. When these cores are in position to be placed in the mold make bottom of vents up and then fill the vents with small coke-ash dust which must be placed in a stove over night to insure freedom from moisture. These core bars through being slightly tapered can be removed easily from the casting and filteration overcome.

Run these castings always from the bottom neck and by doing so the hot metal always is obtained in the center of the casting due to the spin of the metal. That also gives



Suggested Type Core Bar

a soft center allowing the outer extremities of the roll to contract with the least resistance. Only a good refractory sand should be used for the core particularly so at the point where the hot metal flows directly from the runner against the core.

It is quite satisfactory to lap the core where the runner comes in a direct line with the wire after the wire has been thoroughly cleaned and tarred. Also a little tin plate wired on the core is satisfactory. Tarring the cores also is quite good. If the core has been dried too quickly causing cracks all over the core, burning the hay or hemp band around the barrel, and too great a heat used in drying core without doubt will encourage filtration. A *paint* or blacking which would be quite all right for cores of this description where filtration is encountered would be as follows:

> 4 buckets finely ground silica; 4 buckets finely ground crucible pot; 1 bucket china clay; 2 buckets black lead, and 1 quart of coregum or similar core bond.

WALTER BARKER

Sheffield, England

EDITOR'S NOTE:

Our correspondent apparently has read the original question and answer hastily and thus received a mistaken impression. His comments while admirable in themselves, unfortunately are based on a set of conditions and statements which do not appear in the original description to which he takes exception. The illustration accompanying the story showed a chilled, hollow, cast iron roller 30 inches outside diameter, 25 inches inside diameter except at both ends where the opening was reduced to a hexagon 18 inches across the flats. In other words the metal in the casting was 2½ inches thick. The casting was poured from a mixture containing 30 per cent car wheel scrap, 30 per cent pig iron and 40 per cent common scrap. The casting showed a crack ¾-inch wide from top to bottom.

In our reply we pointed out that the silicon content of the mixture, approximately 1.40 per cent, would not impart much of a chill to a casting 2½ inches thick. Mr. Barker writes: "You mention that the chill *required* is 2½ inches thick." He then chides us for suggesting that 1.40 silicon iron would induce a chill of that depth!

In another place he refers to heating the chill and pouring the iron through a spinning gate in the bottom neck to prevent the roll from cracking. We do not see what application this remedy has for a hollow shell roller 2½ inches thick, 30 inches diameter, 30 inches in length and without any neck either top or bottom.

Touching on the core he asks: "If, as you suggest, filtration in the core is the cause (of the crack) why use a barrel to build a core upon?" He then proceeds to describe a core built upon a solid bar. To this we must point out that we did not at any time refer to filtration. We did not suggest a barrel to build the core upon. We described a plain dry sand core made in the form of a shell a few inches thick. In brief, Mr. Barker is referring to one thing and unfortunately we were referring to another. All of which would seem to indicate that the adoption of definite foundry terms is desirable.

Pacific Coast Founders Elect Officers

The following officers were elected at the annual meeting of the Pacific Coast Founders association Oct. 16: President, Charles J. P. Hoehn, Enterprise Foundry Company, San Francisco; vice president, F. G. Johnson, The American Foundry Co. Inc., Alameda; treasurer, Charles A. Kingwell, Kingwell Bros. Brass Foundry, San Francisco; secretary, Maurice S. Greenberg, M. Greenberg's Sons, San Francisco. The following directors were elected: Charles J. P. Hoehn, F. G. Johnson, Charles A. Kingwell, Maurice S. Greenberg, Fred C. Kobely, Bethlehem Shipbuilding Corp., San Francisco, and Elmer S. Anderson, Anderson-Barngrover Mfg. Co., San Francisco. S. M. Truitt continues as manager of the association.

Questions & Answers on FOUNDRY PRACTICE

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall
Cast Steel

M. A. Schwartz
Malleable Cast Iron

J. W. Bolton
Gray Cast Iron

All questions should be addressed to the Editor, The Foundry, Penton Building, Cleveland.

GENERAL

New Sand Gives Lift

QUESTION

Has anything been published on the subject of concrete copes? We have a cope on which some of the hanging edges are extremely delicate and which we are afraid will wash away if formed in green sand. Dried cores cannot be introduced readily and our oven capacity is not sufficient to handle the proposed output of molds if the entire cope is made as a dry sand core. We have been advised to ram the copes in the usual manner with a mixture of core sand 12 parts and portland cement 1 part and then allow the copes to air dry for two or three days. It is claimed that this method will reduce the cost of making the molds. Danger of contaminating the sand heaps will be removed by discarding the copes practically intact after the castings are poured. We have been informed that a sand mixture of this kind is used in some southern foundries for pressure fitting cores.

ANSWER

Comparatively nothing has been published on the subject of cement-sand mixtures either in molds or cores for the simple reason that the material never has been adopted permanently by any foundry. At one time or another many foundrymen have tried to introduce it but almost without exception they have discarded it. So far as we know, only one prominent southern foundry is now using cement-bonded, air-dried cores. At this plant this type of core has been used for the past two years and apparently is giving every satisfaction. However, the management was forced through some trying experiences before all the wrinkles were ironed out of the problem. At this plant the cores are formed in metal coreboxes mounted on a machine which blows the sand into the corebox under pressure. The employees' hands only come into contact with the sand to a slight extent. Where the sand has to be rammed and handled by hand, it rapidly wears the skin from the fingers, so that the coremaker, irrespective of his willingness to continue, is forced to resign. This has been the experience of foundrymen up to the present. We do not think you have been well advised in selecting this material for a cope on the small job to which you refer, 18 inches square and with delicate hanging edges. The mixture has not sufficient bond to enable you to lift the cope from the mold in the usual manner. The only way to handle the job would be to ram the cope on a rollover machine and remove the pattern from the cope after it had been rolled over. If you are ramming the mold by hand the pattern will have to come up with the cope.

Your proposal to discard the material in each cope after it has served its purpose entails an unnecessary expense. It will not amount to much where only a few molds are made, but it will amount to quite an item where the production is large. Molding sand and cement are comparatively cheap in your city, but the expense of collecting the discarded sand, hauling it away and dumping it, also must be taken into account. The factor of small or large production also enters into the proposal to ram the copes and allow them to harden for a few days before they are used. The idea is feasible if only a few molds are involved, but it is impracticable, uneconomical and expensive if applied to a great number. Three sets of copes will be required. One in the green stage today. One in the drying stage tomorrow and one in the dried state when the castings are poured on the third day.

Without actual examination of the delicate hanging edges to which you refer we cannot say positively, but we are of the opinion that this feature can be taken care of by making the cope in the usual manner with the exception that the hanging edges be formed from new sand. Spray the face of the finished cope with molasses water and dry it with a gas torch and you will find that the sand will not wash in front of the iron. A thin solution of any water-soluble, core binder will serve as well as the molasses water. A little plumbago incorporated in the blackwash will insure an extra clean face on the casting.

Q & A

Pattern Halves Alike

QUESTION

Kindly explain to me what is meant by a pattern that is symmetrical along the parting line. Also how does a knowledge of ferrostatic pressure reduce the amount of scrap in a foundry.

ANSWER

A pattern that is symmetrical along the parting line is a split pattern in which the cope and drag halves are alike. Thus a single half pattern mounted on a plate may be employed alternately to make copes and drag molds. A number of half patterns mounted on a plate with due regard to center lines serve in the same manner. In some instances the cope may be placed directly on the drag with the right end of the cope coinciding with the right end of the drag. In other instances the cope must be swung

through an arc of 180 degrees horizontally so that the left end may coincide with the right end of the drag. This feature and many others are covered fully in the series of seven articles on pattern mounting methods which appear in *Tales from the Gangway*.

A knowledge of ferrostatic pressure reduces scrap in the foundry in the same manner and for the same reason that an intimate knowledge of any other feature of foundry practice helps to reduce the scrap. For example, a man with a knowledge of ferrostatic pressure will provide ample clamps or weights to prevent the cope from lifting when the mold is filled with metal. He knows that the pressure on the face of the mold is increased in proportion to the height of the head and governs himself accordingly. In that manner he prevents twisted, over weight distorted castings. Also he prevents *runouts* in flasks where otherwise the pressure would force the drag and cope apart at the joint.

Q & A

Pickle Cleans Castings

QUESTION

Do you know of any prepared chemical for dissolving core sand, etc., from gray iron castings. We are under the impression that the castings can be dipped in a certain solution which dissolves the cores.

ANSWER

The chemical employed extensively in the gray iron foundry at one time and still used for cleaning sand from the surface of gray iron castings is hydrofluoric acid. One part of 48 per cent acid is added to 30 parts water and the mixture either is poured over the casting or the casting is immersed in the liquid. Sulphuric acid also is employed for pickling gray iron castings. One part of ordinary vitriol is mixed with 4 to 6 parts of water. Care must be taken to pour the acid into the water and not the water into the acid. The solution is kept in a lead lined wooden vat with a wood grating resting near the bottom. The castings rest on the grating and the sand drops through to the bottom of the tank. After they are clean the castings are washed in hot water, about 80 degrees Cent. (175 degrees Fahr.). To neutralize any acid, they are immersed in a solution made of lime, 20 pounds and water 100 gallons. Then they are placed on an inclined screen and dried. Workmen should be cautioned in handling either of these acids as they cause severe burns.

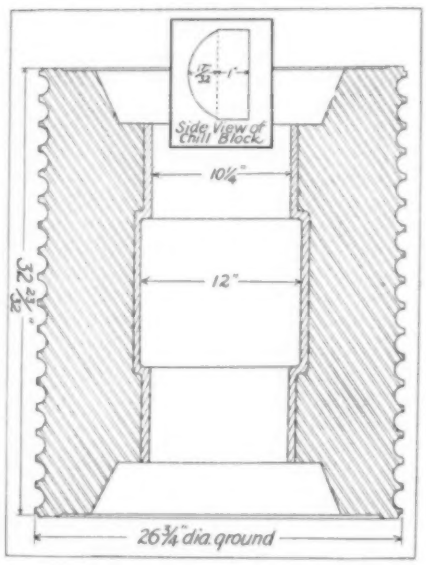
The foregoing refers only to the removal of sand or scale burned on the face of the casting. The method is not employed to dissolve whole cores out of the casting. If your cores are of a character that will not clean readily from the casting, the proper procedure is to change the core making practice and materials. A preventative measure always is more satisfactory than one that attempts to be remedial.

GRAY IRON

Cast Chilled Roll

QUESTION

We are enclosing a tracing of a chilled roll casting 27 inches diameter, 33 inches in length with a 10-inch diameter hole through the center. The outside of the roll mold is formed with a set of small iron blocks 2 inches square and 1½ inches thick, set close together and convex on the side next to the casting. This arrangement produces a series of pockets on the surface of the casting, 17 in a row vertically and 48 in a row on the circumference. We have been casting a soft center or shell approximately 1 inch thick in the center so that it might be bored to fit the shaft. All other finished surfaces, including pockets are finished by grinding because of hardness of the metal. Do you think the small iron blocks, 1½ inches thick, exert any chilling effect on the comparatively thick body of metal in the roll? What is a suitable analysis for a casting of this kind?



Depressions in the Surface Are Formed by Small Iron Blocks

ANSWER

You do not state whether the small chill blocks are backed by sand or by a chill ring. If they are backed by sand and if your iron is so hard that you have to place a soft iron liner in the roll, light chill blocks exert little additional chilling effect. If they are backed by a heavy chill ring, then undoubtedly they impart a heavy chill to the face of the casting. However, in the latter event a different grade of iron might be employed, one that might be machined in the center, that is unless you want to have hard metal all the way through the casting. Under the present highly developed methods of grinding, we see no valid reason or necessity for inserting a soft metal liner in the casting. The inside of a hard, or comparatively hard casting, can be finished as readily as the outside by grinding. The following analysis will serve if the iron is to be subjected to the chilling effect of a regular ring chill enclosing the small blocks: Silicon, 1.20 per cent; sulphur, 0.12 per cent; phosphorus, 0.30 per cent, and manganese, 0.80 per cent. Presumably the small iron blocks may have been designed primarily to take the place of sand cores and not for any chilling effect they might exert on the face of the casting.

Q & A

Carbon Content Is High

QUESTION

Can you tell us whether petroleum coke can be used in a gray iron cupola and if good results can be obtained with it?

ANSWER

Most cokes made from coal contain approximately 90 per cent carbon and 10 per cent ash. Many petroleum cokes contain about 99 per cent carbon with a negligible ash content. Since carbon is the combustible element in coke, it is obvious that the heat value of petroleum coke is higher than that of coal coke. However, many petroleum cokes are weak in cell structure and may be crushed too much in handling or under the burden of the cupola charge. Recently a petroleum coke said to be made by a special process to insure good cell strength has been used to melt red brasses in a small cupola. Petroleum cokes mixed with coal cokes are said to increase the melting rate and the temperature of the iron. According to Boegehold, *Transactions* of the American Foundrymen's asociation, 1929, the combustibility of petroleum is high. One detracting factor to the use of petroleum coke is its high price.

Q & A

Sheave Wheels Crack

QUESTION

We are making a sheave wheel 26 inches diameter which has to be chilled to a depth of 1/16-inch in the groove. The wheel has six arms which are ribbed top and bottom. These castings are poured from a 10 or 15 per cent steel mixture to secure a chill, and the arms crack near the rim. When we pour them from a soft mixture, the castings do not crack, but the rim does not show chilled fracture. Can you suggest a suitable mixture, precautions to take after the casting is poured, or any change in the design of the pattern to insure satisfactory castings.

ANSWER

We assume you are pouring the sheave on the hub, since that is the usual practice on practically all kind

of wheels. In the majority of cases the position of the gate is immaterial, but in this particular instance where a thin rim is cooled quickly by the application of a chill, the central gate accentuates the difference that normally exists in the contraction time between the rim and the center. You can maintain an approximate balance by stripping the hub immediately after the iron has solidified and at the same time keeping the rim well covered. The easiest way is to turn the flask on edge, remove the bottom board, dig the sand away around the hub and remove the center core.

Some irons chill more readily than others of a similar chemical analysis. Also, some irons become more brittle than others when introduced into a mixture where the silicon content approaches 2.00 per cent. A suitable analysis for this particular wheel in which a chill of only 1/16-inch is required will show: Silicon 1.75 per cent; sulphur, under 0.07 per cent; phosphorus, 0.20 to 0.30 per cent, and manganese, 0.70 per cent. You will note that the sulphur and phosphorus are held to a low point and this is one of the most important features to prevent the casting from cracking. The design of the wheel is not abnormal. As an added precaution you might place a runner in the space between two arms and cut the gates into both arms, instead of the usual gates on top of the hub.

Q & A

Castings Are Warped

QUESTION

We recently found a peculiar situation in making to tailstock bases for lathes. After these tailstock bases are scraped thoroughly and laid aside for several hours, we find that they are out of line from 0.002 to 0.006-inch. Has any one else experienced this trouble, and what is the cause?

ANSWER

Your letter does not quite make clear whether the tailstock itself is out of line, or whether it is the lathe bed on which the tailstock may be fitted. It happens that lathe beds sometimes warp or twist due to internal strain, particularly if they are long. This warping or bending up or down is corrected by giving the pattern a camber or a bend in the opposite direction. The camber is determined by the judgement of the foundryman and is the result of experience, or it may be a cut and try method.

Some machinery makers take a rough cut on their castings and then allow them to age for long periods exposed to the atmosphere. After this period of exposure the castings are sandblasted and the final machining performed. Another way of relieving internal strain is to subject the castings to heat treatment. A heat treatment at 1200 to 1600 degrees Fahr. for 1 or 2 hours will normalize the casting. This treatment also may increase machinability. The cold castings should not be placed in a hot furnace as they may crack. The heating should be uniform and gradual. The time mentioned is the holding or soaking period. Cooling also should be done slowly. In other words the castings should remain in the furnace until they are black before removing to the air.

STEEL

Sand Mixtures Vary

QUESTION

Can you give me any information on the most suitable sand mixtures for green sand molds for steel castings? The steel is melted in the open-hearth furnace and the castings range in weight from 100 to 2000 pounds.

ANSWER

The first suggestion we have to make is that only the lighter castings should be poured in green sand. The heavier ones had better be poured in dry sand unless the sections involved are quite light. The mold in which the casting is poured must retain its shape without spalling, fusing or softening and carry away the gases formed. The sand must have a high fusing point and be permeable, that is to say to have good venting power. Usually steel molding sands contain at least 90 per cent silica and many times as high as 98 per cent. The ideal material would be one in which all the particles are spherical and of the same size. However, that hardly is attainable.

Giving definite sand mixtures that will be suitable for your work entails considerable difficulty because of the variation in sands and in clays obtained from different districts. Consequently, a satisfactory mixture in one foundry center may be the opposite in another place. For example, the backing sand in one foundry is composed of old sand that has been through a sand reclaiming system. About 1 per cent fireclay and enough water to give 3 per cent moisture content is added to the reclaimed sand. The facing sand is composed of 2500 pounds of new silica sand, 80 pounds of fireclay, and a small quantity of bentonite. The moisture content is about 3 per cent.

A foundry making castings around 56 pounds in weight using old sand that has been through a sand handling system, adds about 0.33 per cent bentonite at each rebonding. Moisture averages from 3 to 3½ per cent. A large foundry making light and heavy castings uses the following facings for green sand work: Light castings —400 quarts moist new silica sand; 12 quarts of bentonite; 10 quarts of silica flour, and 2 pounds of dextrine. For the heavy castings the facing mixture consists of 30 shovels of moist new silica sand; 10 shovels of washed and dried silica sand; 3 shovels of silica flour; 2 quarts of dextrine, and 26 pounds of bentonite.

From the information presented you can see that the molding sand mixtures vary from foundry to foundry. Each foundry has its own particular way of mixing its facings. By careful experimenting with the sands you have, and the knowledge you have of the results obtained from various mixtures, you should be able to standardize on mixtures for the different types of castings you make. We also suggest that you consult Chapter VIII of Hall's *The Steel Foundry*. The chapter referred to deals with molding, pouring and digging out steel castings.

MALLEABLE

Reactions Are Described

QUESTION

What are the reactions involved on adding mill scale or iron oxide to a molten metal bath in the air furnace? What is the sequence of losses of carbon, silicon and manganese, and the percentages of loss of these elements for a given oxide addition?

ANSWER

In general the reactions may be stated to be the reduction of the mill scale say iron sesquioxide to iron, and the formation of carbon monoxide, carbon dioxide, and manganous oxide from the resulting oxygen plus the several elements of the bath. Which element oxidizes first depends primarily on temperature and somewhat upon composition. Whether carbon monoxide or carbon dioxide forms depends upon temperature also, but above the melting point the gas formed is almost exclusively carbon monoxide.

At low temperatures corresponding to *cold* molten iron, silicon is more readily oxidized than carbon; at high temperatures such as those used in steel melting, the carbon oxidizes more readily. Similar statements may be made for the elements manganese and carbon. Generally speaking the reactions do not occur in sequence, but all together at rates varying with temperature so that as temperature changes, one or another predominates. There is never sufficient accurate knowledge of temperature in practice to permit more than an approximation of what is likely to happen.

The total loss of carbon, silicon and manganese will be such that the oxygen content of the resultant carbon monoxide, silica and manganous oxide equals that of the added mill scale. The percentage of any one which will be oxidized depends as previously outlined on the temperature so that the loss of the elements separately is not predictable except roughly. To exercise proper control over a bath by the method of ore or scale additions requires a preliminary analysis after the addition and suitable further adjustment of composition.

Problems in Nonferrous Founding

By Charles Vickers

Metal Causes Trouble

We are having considerable trouble with a casting which we are sending you. We have marked where the casting leaks under a pressure of 150 pounds per square inch. The mixture is 20 pounds copper; 1 pound lead; 1 pound zinc; and 1½ pounds of tin. We melt in crucibles in coke-fired furnaces and pour at 1850 degrees Fahr. We use no flux, and have used the same mixture for years in valves and so forth, but this is a new style and we have had trouble from the start. Is there anything wrong with our mixture, and if so what would you suggest as a remedy. In addition to the leaks, cracks show up on the threaded ends after they are machined. We blow the cores when the castings are hot. We have examined the castings carefully and have failed to find any appearance of cracks at this stage. Our customer contends that it is the fault of the metal, or by blowing the cores while the castings are hot. We, however, feel that the fault is due to the method of machining, and think that the theading is done at one operation and our contention is that the taper tap spreads and cracks the castings. We would like to have your opinion as it may help us to solve the problem and get into production at an early date as the customer is pushing us for castings.

To judge the mixture it has to be brought into percentages. These are 85.10 per cent copper: 4.25 per cent lead; 4.25 per cent zinc; and 6.40 per cent tin. The 85-4¼-4¼-6½ copper-lead-zinc-tin alloy will never stand pressures unless deoxidized, but even when deoxidized it will not stand pressures if poured at 1850 degrees Fahr., for this is the pouring temperature of an alloy of 80-10-10 plus 0.5 per cent phosphorus, and at that it is a trifle low. The following alloy will withstand 150 pounds air pressure, when the casting is immersed in water: 84 per cent copper; 6 per cent zinc; 5.50 per cent lead; 4.50 per cent tin. In addition add to the metal 10 minutes before it is taken from the furnace, 1½ ounces of phosphor-copper containing 15 per cent phosphorus, for each hundred pounds of alloy.

Get a reliable pyrometer and keep it calibrated and take the temperature of every heat, and pour at 2150 degrees Fahr., never lower, but it may be 2200 degrees to start when there is a long line of molds to be poured. The cracking is due to the metal not being deoxidized, and is caused by intercrystalline films of oxides such as deposited zinc oxide. The blowing out of the cores has nothing to do with this cracking. Deoxidize your metals, but do not overdeoxidize. pour hot, and above all, get the metal hot in the furnace. It will not hurt it to be brought to 2300 degrees Fahr., in the furnace.

Q & A

Fittings Turn White

We are washing our brass fittings in water, and after they are washed they all turn white. Can you recommend something to put into the water when they are tumbled, so that when taken out they will not be white? All the water we have tried has turned the castings white.

We are at a loss to understand in just what way the castings are whitened. If it is a deposit of some powdery substance white in color, the water must contain some alkaline substance. In that case the natural color of the brass should be restored by immersing them for a few minutes in water acidulated with muriatic acid. It would not be advisable to add the acid to the tumbling mill if it is fitted for running water. If the water remains in the barrel the acid can be added to the water. However, it is well to consider the action of the acid on the tank or its connections.

Another question that enters is, are the castings white before being tumbled? If so, the metal contains aluminum and the color so imparted cannot be tumbled off. Neither can it be removed by weak acids, but it will be eliminated when metal free of aluminum is used.

Q & A

All Metals Shrink

Can you furnish us with a formula for a metal that has no shrinkage?

There are no metals or combinations of metals known that occupy the same volume they have in the molten and the solid state. However, some alloys shrink less than others, and one that finds considerable application in making patterns consists of 50 per cent of tin and 50 per cent of zinc.

Ingots Should Be Used

We manufacture large quantities of brass fittings using cocks and faucets with addition of 10 per cent copper and we recently started to use the fittings only, omitting the copper addition. We tap the fittings using a tapping machine and we have been troubled with a few complaints of split fittings. We melt in a crucible furnace using hard coal on the bottom with coke around the sides, of the crucible. We are sending samples of the castings which we have broken down by squeezing them in a patternmaker's vise. We find that most of our trouble comes on the innerside seam on the ell and tee. There generally is a black trace in the metal as you will note.

The scrap brass mentioned may consist of a considerable amount of yellow brass, which will increase the zinc contert of the alloy being used. This is not good. The fractured surfaces of the brass show a poor composition of brass and consequently the line of fittings you are turning out are quite inferior to what the trade usually demands.

Owing to the diversified character of the scrap metal, we believe that the quality of your product would be greatly improved if, instead of using scrap metals, ingot metal was substituted. The ingots are handled and melted easily, and the loss is less. Although the ingot may cost slightly more than the raw scrap, the ultimate result is profitable. The brassfounder will make more money by sticking strictly to the making of castings, and by getting production than by combining a smelting business with his foundry. There is a number of compositions available in ingot form, but for these fittings it is not advisable to select a yellow brass ingot, because then there will be other losses to offset the gain obtained by using the cheaper metal.

To each hundred pounds of metal add 1½ ounces of phosphor copper, just before it is taken from the furnace, or when it is removed and skimmed. About 5 minutes should elapse after stirring in the phosphorus before pouring the molds. The black trace complained of is caused by the presence of oxides. A reliable dealer in ingot metals can be selected from the advertising pages of The Foundry.

The FOUNDRY Family Photograph Album

Upper Left

E. C. BAUER
Kensington Steel Co., Chicago

Upper Right

J. A. DUNCAN
William Duncan Co., East Boston, Mass.

Lower Left

N. BERG
Euclid Foundry Co., Euclid, O.

Lower Right

J. D. ALEXANDER
American Foundry Equipment Co., Mishawaka, Ind.

NONFERROUS MATERIALS OF CONSTRUCTION

IN AIRCRAFT ENGINES

By R. R. Moore

Two outstanding demands of the aircraft engine from the construction standpoint are lightness and reliability. These qualities oppose rather than assist each other and, therefore, intensify the importance of the type and quality of the materials used.

The metals employed in the construction of aircraft engines represent such a great variety of types and forms that they cover practically the entire field of structural alloys. These metals vary in weight and strength from the light aluminum and magnesium alloys to the heavy bronzes.

The total weight of a radial air-cooled engine is made up of about 45 per cent aluminum alloys, about 3 per cent bronze and the remaining 52 per cent steel. There is a negligible amount in rubber, felt, vellum, cork, etc. The relatively large percentage of light alloys used in aircraft engines accounts of course for their light weight. The purpose of using light alloys is not only to cut down the dead weight of engines, but also to reduce the weight of reciprocating parts.

CONSIDERABLE ALUMINUM USED

Aluminum-base alloys are particularly well adapted to aircraft construction because of their lightness and thermal characteristics. Without the light alloys aircraft and aircraft engines would not have reached their present stage of development. If all the aluminum alloys used in an air-cooled aviation engine were replaced by steel, cast iron, or bronze, the weight of the engine would be about doubled.

The more important parts made from the alloys of aluminum or magnesium are the crankcase, pistons, cylinder heads, pump bodies, diffuser disk, supercharger impeller, intake pipes, housings, covers and cowling. In Table I is given a list of alloys that have been used and their physical properties. The practice among engine manufacturers is not uniform, there being considerable difference as to the alloy used and the form of manufacture.

Crankcases are made from any of the alloys *A*, *B*, *C* or *D* shown in Table I. The actual alloy used depends upon the type of engine and the part of the crankcase to which it is applied. The highest tensile strength and elongation is obtained from alloy *C* when heat treated. This alloy is, therefore, used on the most highly stressed parts. Alloy *D* has been used on small four-cylinder

This article is abstracted from a paper presented by the author at the symposium on aircraft materials held by the American Society for Testing Materials at Atlantic City, N. J., June 27, 1930. Mr. Moore is chief metallurgist, Wright Aeronautical Corp., Paterson, N. J.

(*Continued on Data Sheet No.* 838)

NONFERROUS MATERIALS OF CONSTRUCTION

IN AIRCRAFT ENGINES

(*Continued from Data Sheet No.* 837)

engines. This, however, is not general practice as objections to its use are found in the low proportional limit and its susceptibility to salt water corrosion.

TABLE I.—LIGHT ALLOYS USED IN AIRCRAFT ENGINES.

Alloy	Chemical Composition								Alcoa Number	Yield Point, lb. per sq. in.	Tensile Strength, lb. per sq. in.	Elongation in 2 in., per cent	Specific Gravity	Form
	Aluminum, per cent	Copper, per cent	Silicon, per cent	Iron, per cent	Zinc, per cent	Magnesium, per cent	Nickel, per cent	Manganese, per cent						
A	92	8	...	....	...	...	....	....	...	11 000	18 000	1.0	2.86	Sand Casting
B	88	12	...	....	...	...	....	....	...	13 000	20 000	1.0	2.95	Sand Casting
C	94 65	4.5	0 85	...	...	...	..	..	195	18 000	25 000 to 35 000	6 to 11	2.77	Sand Casting—Heat Treated[a]
D	85 50	2 75	...	1.50	10.25	...	..	..	...	12 000	25 000 to 34 000	3 to 6	....	Sand Casting
E	92.5	4 0	...	....	...	1.50	..	..	...	27 000	28 000 to 38 000	1.0	....	Sand Casting—Heat Treated[b]
F	88.5	10 0	...	1 25	...	0.35	..	..	122	20 000	35 000 to 40 000	1.0	....	Sand Casting
G	93.0	4 0	3 0	...	...	...	...	...	...	....	17 000	1.5	...	Sand Casting
H	94.0	...	6 0	...	...	...	...	...	...	7 000	19 000	3 to 7	....	Sand Casting
I	7.0	...	...	...	...	92.6	....	0 4	...	9 500	32 000	8	1.74	Sand Casting—Heat Treated[c]
K	87 0	..	13.0	....	...	...	...	..	...	....	28 000 to 33 000	1 to 4	....	Die Casting and Permanent Mold
L	98 5	...	0 90	....	..	0 60	.....	.....	518	30 000 to 40 000	45 000 to 50 000	10 to 18	2.69	Forging—Heat Treated[d]
M	93 9	4 5	.0 80	...	...	...	..	0 80	258	30 000 to 40 000	55 000 to 63 000	16 to 25	2.79	Forging—Heat Treated[e]
N	94.8	4 0	...	...	...	0.50		0.70	178	30 000 to 40 000	55 000 to 63 000	18 to 25	2.74	Forging—Heat Treated[f]

[a] Heat to 950 to 975° F. and soak, quench in water, hold at 212° F. for one hour.
[b] Heat to 935 to 975° F., quench in water, hold at 450° F. for one hour.
[c] Heat to 790° F., quench in water, hold at 250° F. for three hours.
[d] Heat to 950 to 985° F., quench in water, hold at 320° F. for eighteen hours.
[e] Heat to 950 to 985° F., quench in water, hold at 290° F. for eight to fifteen hours.
[f] Heat to 925 to 960° F., quench in water, hold at 212° F. for one hour.

In some radial engines the main crankcase section is a forging made from alloy *L* which is then heat treated. This, of course, gives a much stronger part.

(*Continued on Data Sheet No.* 839)

THE FOUNDRY DATA SHEET, NOV. 15, 1930
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

RICHARD HENDERSON & COMPANY-CALLED THE TRANSYLVANIA COMPANY IN 1775-
SEND FORTH DANIEL BOONE TO EXPLORE TENNESSEE AND KENTUCKY

Fig. 1—Daniel Boone Starts Explorations. Fig. 2—The Treaty of Watauga Transferring A Large Tract

Tablets Honor Kentucky Pioneers

Henderson County Historical Society Unvails Plaques Which Show the Courage and Resourcefulness of Early Settlers

COURAGE and resourcefulness of nine men who cast their tall shadows over the history of Kentucky and the region between the Alleghanies and the Ohio, have been perpetuated in a series of bronze tablets affixed to the front of the courthouse in Henderson, Ky. The tablets were the gift of Judge Robert Worth Bingham, a descendant of James Hogg, one of the pioneers, and were dedicated and unveiled under the auspices of the Henderson County Historical Society. At the ceremony which marked the dedication, many of the speakers and others on the platform were descendants of the nine original members of the Transylvania company, credited with opening the wilderness beyond the Alleghanies: namely Col. Richard Henderson, James Hogg, William Johnston, Thomas, David and Nathaniel Hart, John Luttrell, Leonard Henry Bullock and John Williams. The company engaged Daniel Boone to explore the Kentucky country, negotiated the great treaty at the Sycamore shoals of the Watauga, commissioned the cutting of the the Transylvania trail by Daniel Boone, Richard Gallaway and associates, built the Transylvania fort at Boonesborough, convened the first legislative assem-

Fig. 3—G. H. Honig, Sculptor, Is Shown dt the Center, H. Holdkamp and C. W. Dickmann, Art Bronze & Aluminum Co., Right and Left Respectively

MARCH 31 1797 GENERAL SAMUEL HOPKINS AS AGENT AND ATTORNEY IN FACT FOR THE TRANSYLVANIA CO WITH
COLONEL THOMAS ALLEN THEIR SURVEYOR LAID OFF THE TOWN OF HENDERSON NAMED FOR RICHARD HENDERSON

ALL POWER IS ORIGINALLY IN THE PEOPLE
RICHARD HENDERSON GOVERNOR OF TRANSYLVANIA ADDRESSING THE FIRST KENTUCKY LEGISLATURE
AT THE TRANSYLVANIA FORT AT BOONESBOROUGH KENTUCKY MAY 23 1775
THE FOUNDERS OF WESTERN DEMOCRACY
WHO WERE FOLLOWED BY THOMAS JEFFERSON- POWER BELONGS TO THE PEOPLE
AND ANDREW JACKSON—THE PEOPLE MUST RULE

Fig. 4—Henderson Was Laid Out in 1797 by Samuel Hopkins. Fig. 5—Meeting of the First Kentucky Legislature

Fig. 6—The Tablets Have Been Placed on the Court House at Henderson

bly ever held west of the Alleghanies and labored mightily in populating and defending the new country.

Agreement by which the Transylvania company obtained possession of an area including parts of what now are Kentucky, Virginia, North Carolina and Tennessee was the most colossal real estate transaction ever negotiated by private individuals in American history. For $250,000 the company purchased from the Cherokees their claim to a vast area variously estimated at from 17,000,000 to 20,000,000 acres.

The tablets were designed and modeled by G. H. Honig, a local sculptor, shown in the center of one of the accompanying illustrations. They were molded and cast at the foundry of the Art Bronze & Aluminum Co., Evansville, Ind., represented by H. Holdkamp (left) and C. W. Diekmann (right) in the same illustration.

The molds were made in a fine grade of brass molding sand and the surface was sprayed with molasses water and dried before the metal was poured. The metal was melted in an open flame, oil fired furnace made by the United States Smelting Co., Belleville, Ill.

Fig. 7—Tablet of Judge Richard Henderson

English Firm Will Make Sand Spun Pipe

Staveley Coal & Iron Co. Ltd., Derbyshire, Eng., is building a foundry, 420 x 200 feet, consisting of a central shop and several auxiliary bays, for the manufacture of cast iron pipe under license from the Sand Spun Pattents Corp. of America. The company has been experimenting with the process for some time. Pipes will be cast in 16 foot lengths of 4, 6, 8, 10 and 12-inch diameters and will be of the bell and spigot type. The Staveley company expects to have the new plant in operation by the middle of 1931.

Chain Belt Executives Are Advanced

C. F. Messinger, vice president and general sales manager, Chain Belt Co., Milwaukee, has been elected general manager. H. S. Greene, formerly connected with the Barber-Greene Co., Aurora, Ill., succeeds him as general sales manager and Brinton Welser, formerly secretary, has been elected a vice president and a director. J. C. Merwin has been elected vice president. A. R. Abelt has been named secretary and W. H. Brandt, formerly assistant secretary, becomes assistant to the president.

Ironton Fire Brick Co., Ironton, O., recently established a new district sales and service office at 1409 Fletcher Savings & Trust building, Indianapolis, under the direction of Carl E. Von Luhrte.

JAMES HOGG-1776-EMISSARY FROM THE COLONY OF TRANSYLVANIA TO CONTINENTAL CONGRESS. PETITIONS THAT TRANSYLVANIA BE RECEIVED AS THE FOURTEENTH AMERICAN COLONY.
JEFFERSON WISHES FREE GOVERNMENT ESTABLISHED BACK OF VIRGINIA. JOHN ADAMS DECLINES TO SUPPORT THE DANGEROUS INDEPENDENCE AND REPUBLICAN NOTIONS OF THE TRANSYLVANIANS

THESE SIX TABLETS PRESENTED TO THE HENDERSON COUNTY HISTORICAL SOCIETY FOR THE COUNTY OF HENDERSON, KENTUCKY, BY
ROBERT WORTH BINGHAM
AND
UNVEILED OCTOBER 11, 1929. COMMEMORATE THE SERVICES TO THE NATION OF THE TRANSYLVANIA COMPANY AND ITS PRESIDENT, RICHARD HENDERSON, FOR WHOM THE CITY AND COUNTY ARE NAMED.
COMMITTEE
ARCHIBALD HENDERSON, CHAIRMAN
ROBERT WORTH BINGHAM
SUSAN STARLING TOWLES
LILLIAN WALKER THIXTON
WILLIAM HENDERSON SOAPER

Fig. 8—Transylvania Petitions Continental Congress To Be Received as Fourteenth State. Fig. 9—Tablet Telling of Erection of Markers

Light Alloy Pistons

Are Cast in Permanent Molds

By Edmund R. Thews

ALUMINUM alloy pistons of the proper composition, correctly cast, and constructed possess many advantages including: High thermal conductivity, lightness, much lower temperatures of working surface, comparatively little oxidation and scale forming, high degree of machinability, and increase in power (15 to 20 per cent).

Light piston alloys should possess sufficient strength to withstand the shocks and gas pressures imposed at temperatures varying from 200 to 400 degrees Cent. (392 to 752 degrees Fahr.). They must be hard and possess the general qualities of typical red bearing metals in as high a degree as possible to resist the wear of the piston rings, etc. The specific weight of the light alloys should be at a minimum to attain a corresponding decrease of inertia of the moving masses. The saving in weight of the engine, as influenced by the lightness of the piston is of secondary importance for most purposes.

Expansion Must Be Low

Thermal absorption capacity and conductivity must be high. Since heat is applied to the piston head only, overheating is to be avoided, the local heat generated being conducted away and distributed as freely as possible. The coefficient of thermal expansion should not vary too much from that of iron, that is to say, the difference between the thermal expansion of the piston material and that composing the cylinder must be small to avoid too large a clearance between cylinder and piston previous to warming up the engine. Insufficient consideration of this point may cause piston slap on one hand, and seizure on the other.

Piston alloys must be highly resistant to the corrosive action of the fuel and the various products of combustion. The metallurgical, physical and mechanical properties of these alloys must be such as to be readily mixed, cast, heat-treated and worked. The cost of production of light metal pistons must not be prohibitive.

The tensile strength of most light metal alloys decreases considerably with rise in temperature. The tensile strengths at 550 to 600 degrees Fahr. amount to about half of the corresponding values at room temperature. For example, an aluminum-copper piston alloy cast in chill molds gave a tensile strength ranging from 25,500 to 30,500 pounds per square inch at room temperature (70 degrees Fahr.) while at 575 degrees Fahr. the tensile strength dropped to 13,000 to 14,000 pounds per square inch.

By suitably alloying and heat-treating light metals it is possible to attain considerable increase in tensile strengths at elevated temperatures and notable improvements have been attained in this direction. However, with the alloys now used for that purpose increase in tensile strength at the usual operating temperatures almost invariably is accompanied by corresponding increase in specific weight. At the present state of development, aluminum-copper alloys with varying percentages of magnesium, nickel, manganese, silicon, and zinc are used and recommended. Since the copper content of these alloys usually is maintained around 12 per cent, the specific weights are comparatively high.

Addition of nickel and magnesium to light piston alloys appears to lower the specific weights by permitting a considerable decrease of the copper content, and to increase the tensile strength. The tensile strength of an American alloy, containing 4 per cent copper, 2 per cent nickel, and 1.5 per cent magnesium is 29,000 pounds per square inch at room temperatures and 17,000 pounds per square inch at 575 degrees Fahr. Another American piston alloy contains 3.20 per cent of copper, 4.10 per cent nickel, and 0.35 per cent silicon. An English automobile piston contains 5 to 6 per cent copper 0.5 to 1.0 per cent nickel, and around 1 per cent each of zinc and antimony.

Table I comprises a list of some satisfactory light piston alloys produced in America, England, Germany and France. Table II gives the physical and mechanical properties of some European alloys. It may be seen that practically all piston alloys contain copper in percentages varying from 3 to 15 per cent, while only a few European alloys omit this constituent entirely.

While hardness is one of the important factors influencing the sliding properties and the service life of light alloy pistons, this property is not as all-important as is supposed by some authorities. Becker's statement in DER MOTORWAGEN, 25, that a brinell number of 100 is the lowest to give good service under ordinary conditions is disproved by the fact that the hardness of the majority of light piston alloys does not exceed 75 to 95 brinell. The sliding properties of piston alloys are influenced to an equally high degree by the structure of the alloys which, similar to typical bearing metals, must consist of hard particles imbedded in a softer matrix.

Make Iron Additions

A series of new light aluminum alloys containing, in addition to copper, varying amounts of the metals of the iron group, now are being developed which are as hard as good cast iron, although the maximum hardness of these alloys is attained by ageing under the working conditions of pistons. These alloys also have a lower coefficient of expansion. It should be remembered in this connection that the elevated temperatures to which the pistons are exposed exert a certain amount of annealing, which induces a slow, but noticeable, reduction of hardness.

There is a certain divergence of opinion concerning the value of heat treating chill-cast light alloys. It is a well know fact that the typical ageable alloys, such as the straight duralumin mixtures, do not represent satisfactory piston alloys, since under the influence of the working temperatures of cylinders recrystallization is induced which tends to lower quickly the original hardness values of these alloys.

Chill-cast aluminum alloys possess the hard, finely crystalline texture required. Sand-cast alloys, on the other hand are hardened by quenching in cold water from a temperature of 900 to 930 degrees Fahr. The same heat treatment may become necessary in the case of chill-cast alloys if the hard surface layer is removed by machining previous to finish grinding the piston.

An exception to this rule is frequently made in the case of the modern piston alloys containing copper, nickel and magnesium in addition to aluminum. The alloy L 24 in Table I always is heated at 950 degrees Fahr. for 10 to 12 hours and quenched

in boiling water. The castings then are held in boiling water a number of hours to accelerate precipitation of the insoluble constituents in the highly dispersed state required to induce the necessary degree of hardness. This alloy is now replacing the group of straight aluminum-copper alloys (Nos. 9, 9a, and 10, Table I) which used to be the most commonly used piston alloys in America, England, and continental Europe.

The thermal conductivity of light aluminum alloys is high. There is little variation in thermal conductivities between the different light alloys.

Table I

Composition of Various Light Alloys

Designation	Al %	Si %	Zn %	Cu %	Fe %	Sn %	Mg %	Ni %	Other elements
1. "KS", German....	Remainder	0.50	..	16.0	0.5-1	..	0.3	0.3	....
2. German.....	do	0.4	0.3	15.8	0.9	..	..	..	....
3. British Air Board..	85.0	..	..	14.0	..	..	..	..	1.0 Mn
4. German.....	Remainder	0.4	0.6	13.9	0.9	..	..	..	....
5. French.....	do	0.5	..	13.0	0.7	..	..	..	....
6. German.....	do	0.4	0.3	13.0	0.8	..	..	..	....
7. German.....	do	2.0	0.3	12.1	1.0	..	..	..	....
8. Aerolite.....	do	..	..	12.0	..	..	..	..	2.0 Mn
9. British Air Board..	do	..	..	12.0	..	..	..	..	....
9a. 2 L 8 English.....	do	..	..	11–13	..	..	..	..	....
10. French.....	do	..	..	11.8	..	..	..	..	....
11. German.....	do	0.4	0.7	11.6	0.7	..	..	..	....
12. Benz.....	do	0.6	1.3	10.3	0.5	..	..	..	....
13. British Air Board..	do	..	..	10.0	..	1.0	..	..	....
13a. American.....	do	..	..	10.0	0.2	..	0.25	..	....
14. Lynite.....	do	..	..	10.0	1.5	..	..	..	0.25 Mn
15. Lynite.....	do	..	..	10.0	1.0	..	0.5	..	....
16. German.....	do	0.3	0.8	9.8	..	..	0.4	..	....
17. French.....	do	0.2	..	9.8	..	4.0	..	1.0	....
18. Lynite.....	do	..	..	8.0	1.5	..	0.5	..	....
19. Began.....	do	..	2.5	7.0	..	..	..	..	....
20. Benz Aviatik.....	do	..	12.0	6.0	1.5	..	..	..	....
21. English.....	do	..	1.2	5–6	..	..	..	0.5-0.8	0.7-1Sb
22. U.S.N. 49-A-1.....	do	0.5	..	6.0	0.5	..	..	..	3.0 Mn
23. Rolls-Royce.....	do	0.2	1.2	5.4	..	..	..	0.5	0.8 Sb
24. Supra German.....	do	20.0	..	5.0	0.5-1.0	..	..	..	2.0 Mn
25. KS Nr. 245.....	do	12.0	..	4.5	0.5-1.0	..	0.7	1.5	1.0 Mn
25a. L 24 English.....	do	..	..	4.5	..	..	1.2-1.7	4.5	....
26. Duralumin.....	do	0.4	..	4.2	0.3	..	0.5	..	0.6 Mn
27. N.P.L.....	Remainder	..	..	4.0	..	..	1.5	2.0	....
28. Y-alloy.....	do	..	..	4.0	..	..	1.5	2.0	....
29. Daimler.....	do	0.7	9.1	4.0	0.8	..	..	..	....
30. American.....	do	0.4	..	3.2	0.1	..	4.1	..	....
31. Curtiss.....	do	..	..	2.5	..	..	1.5	..	....
32. Magnalite.....	do	..	0.5	2.5	..	..	1.3	1.5	....
33. Daimler.....	do	0.7	9.1	2.3	0.8	..	..	..	....
34. Alusile.....	do	20.0	..	1.0	0.5-1.0	..	..	..	....
35. Electron.....	do	2–3	..	..	..	..	Rest	..	....
36. Magnalium.....	Rest	..	..	..	..	..	5.0	..	....
37. German.....	do	..	..	..	..	..	7.0	..	....
38. British.....	do	..	..	..	..	..	..	5.5	....

The chief advantages of the higher thermal conductivity of aluminum alloys claimed are: Increase in power, fuel economy, and elimination of the carbonization of oil under the piston head.

The high coefficient of thermal expansion of all the commonly used light piston alloys is their outstanding disadvantage. Table II gives the various coefficients of expansion of some of the light alloys. Since the expansion of the common light aluminum alloys is large, a considerably greater amount of clearance must be allowed between piston and cylinder at room temperatures. To avoid piston slap due to excessive clearance, or seizure caused by lack of clearance, proper attention must be paid this problem in designing light alloy pistons, particularly when introducing new alloys.

Light metal pistons are cast either in sand, in permanent molds, or in combination sand and permanent molds. Sand castings possess the decided advantage from the foundryman's point of view that runners, gates, risers, chills, etc. may be placed and replaced at will until the best mechanical properties of the castings are obtained. With permanent molds the relative positions have to be judged beforehand, and few changes can be effected after the mold has been constructed.

Permanent molds generally are used for casting all but the complicated types of pistons. Instead of iron and steel molds, various compositions of copper alloys have been used, without however, showing marked advantages. Gray cast iron molds are employed for the production of comparatively small numbers of pistons, gray iron molds with steel cores for larger numbers of castings, and all steel molds for casting more than 4000 to 5000 pistons of the same design.

Steel molds may consist of any high grade steel or of medium hard wrought iron. They must be designed as simple as possible, avoiding too many sections, so as to facilitate the final cutting and grinding operations. The walls of the molds should be made as thin as possible to obtain the rapid cooling of the castings required for the production of suitable pistons.

Sand cores in connection with permanent molds frequently were employed previous to the satisfactory development of the modern all-permanent molds for light alloys. Present foundry practice in Europe restricts use of sand cores to the casting of pistons with exceptionally complicated internal shapes, or where only a few pistons of certain internal shapes are to be produced.

Of the various elements added to the basic aluminum-copper alloys, iron, nickel, manganese, zinc and magnesium from hard compounds imbedded in the softer eutectoid matrix. Compounds such as $FeAl_3$, $NiAl_3$ and $MnAl_3$, appear in form of well distributed scales influencing the hardness of the alloys to a much higher degree than the compounds of zinc, antimony, and magnesium. If both zinc and magnesium are present, a hard compound, $Al_2Mg_3Zn_3$, is formed the hardening influence of which is twice as effective as that of copper. A part from its influence as a mild hardening agent, magnesium exerts a powerful refining action. However, it is oxidized readily and forms drossy inclusions of magnesium oxide in the castings which show up in machining and tend to weaken the pistons.

Sal-Ammoniac Coagulates Drosses

One way of avoiding this difficulty is to stir sal-ammoniac into the melt immediately before casting. Frequent use of sal-ammoniac is to be recommended for all piston metals, particularly when pouring into permanent molds. Better results may be obtained with a pulverized mixture of anhydrous potassium chloride, sodium chloride, and calcium fluoride which eliminates the oxide of aluminum and the aluminum nitride, increasing the fluidity of the melt and the density of the castings. The hardeners used in making up the alloys should also be treated with this mixture.

Copper, manganese, iron and nickel are best added in form of hardeners, copper as aluminum-copper (50 per cent Cu) and manganese as aluminum-manganese (25 per cent Mn). Nickel and iron usually are added to the aluminum-copper alloy. Since copper does not alloy with iron carbides, the iron added should be as free from carbon as possible. Iron carbides is distributed throughout the casting in form of extremely hard nodules, rendering efficient machining treatment difficult. Swedish iron or special iron low in carbon is best suited for this purpose. If ordinary steel or iron is used (in form of turnings) a slag mixture consisting of soda ash and silica sand should be employed to eliminate as much of the carbon as possible. If zinc forms a component of the light metal also, iron may be added as a zinc-iron alloy.

The various white metals of low melting points, tin, zinc, antimony, magnesium, etc. are added shortly before casting. Magnesium is added last to make use of its powerful deoxidizing influence. The probable loss of these metals through oxidation must be considered in calculating the

charge. The addition of these metals, followed by the treatment of the melt with salt mixture takes place at a temperature of not over 1275 degrees Fahr.

The exact melting and pouring temperatures depend upon the composition of the alloys used, weight of the pistons, shape and weight of the mold, and a most important factor, the preheating temperature of the mold. The temperature range applicable to all common purposes is 1275 to 1475 degrees Fahr. The lower the pouring temperatures within this range, the more satisfactory the physical and mechanical properties of the pistons. The preheating temperatures of the molds range from 475 to 850 degrees Fahr.

The alloys usually are melted in graphite crucible furnaces, although iron crucibles may be used for this purpose. The small amount of iron taken up by the aluminum alloys apparently is without ill effects in piston alloys.

In pouring, it is considered best practice not to empty the crucible entirely, but to leave enough metal to form a bath sufficiently deep for the next charge. Oxidation of the white metals thus is reduced to a minimum.

Break Scrap for Foundry in a Special Pit

By J. C. Coyle

Many commendable features have been incorporated in the equipment for breaking gray iron scrap in the yard of the General Iron Works, Denver, Colo. The pit was designed by D. J. Neville, chief engineer of the Stearns-Rogers Mfg. Co., one of the three member companies which pool their interest and make castings at the plant of the General Iron Works.

This pit, is 15 feet in diameter and 9 feet deep, mostly below the surface of the ground. An all-welded ½-inch plate steel shell with a 6-inch angle ring at top and bottom, was placed in the excavation, within the 100-foot sweep of big yard derrick. Below the shell a concrete

The Drop Ball Is Operated by a Magnet Suspended from the Yard Derrick

base 10 feet in diameter and 7 feet thick was poured about a cluster of heavy shaftings, 3 feet long. To absorb the impact of breaking scrap the shell was lined with cottonwood blocks 2 x 10 inches, tightly wedged between the two angle rings, ends outward, forming a spongy wall which is giving excellent service. The concrete bottom of the pit was covered with tough clay to a depth of 12 inches.

A 4 x 5½-foot opening was left in the side of the pit nearest the derrick, so that the operator might have an unobstructed view of the interior to properly manipulate the 3400-pound steel ball with which the scrap is broken, or the electromagnet used in placing and removing scrap. The opening was faced on the inner surface with 2 x 8-inch channels. A 2-inch plank was placed in the channels and covered with a 1 x 6-inch plate, the whole bolted through the block lining and steel shell of the pit. A curtain of ¾-inch chains covers the opening, spaced 4 inches apart by short sections of pipe on the ¾-inch rod on which they are hung. The rod is supported by five 1 x 4-inch bars welded edgewise on top of the shell.

A screen, 7 feet high, was erected around the top of the pit, to protect men passing by, as well as to safeguard trains and other property of the railroad, which passes near the pit. This fence is 2-inch mesh backed with 1-inch mesh, chicken wire. A ½ x 2-inch spring steel band holding the upper edge of the screen is in turn supported by eight ¼ x 2-inch vertical straps bolted in short angle clamps welded to the shell of the pit. The dirt fill around the pit was banked to the top of the shell and thoroughly tamped.

Other types of pit were experimented with, prior to the installation of this one, particularly a square pit in which it was found difficult to get at either scrap or the ball with the electromagnet. The stress to which a pit of this kind is subjected is indicated by the fact that the steel ball splits from dropping upon the scrap and must be replaced periodically. The tough cottonwood lining of the pit is hardly marked by flying bits of metal and the springy construction of the screen above ground successfully resists damage in the same way, while confining small particles of metal to the pit.

Aluminum Institute Chemists Meet

Chemists representing members of the Aluminum Research Institute, Chicago, held a meeting at the Cleveland hotel, Cleveland, on Oct. 28 to discuss the progress that has been made since the previous meeting in establishing a standard method for the analysis of remelt aluminum and its alloys. Due to the numerous elements likely to be encountered, considerable difficulty has been found in obtaining concordant results when the usual methods are employed. However, reports of the co-operating chemists indicate that many of the difficulties have been overcome. While considerable investigation still is necessary, results indicate that a standard method for everyday use by both producer and consumer will be evolved.

E. A. Whitney, formerly manager of the specialty department handling high temperature cements and plastic refractories, A. P. Green Fire Brick Co., Mexico, Mo., has accepted a similar position with the Mexico Refractories Co., Mexico, Mo.

Table II

Physical Properties of Some Alloys

No.	Specific Gravity	Melting point Fahr.	Coeff. of Expansion a	Tensile Strength lbs. per. sq. in.	Elongation per cent	Brinell Hardness	Remarks
1	3.1	1000	22 to 24 × 10-6	24,600 to 31,400	0.5	110 to 130	chill-cast
3				11,200			
22				18,000	8.0		
24	2.7	980	17 to 19 × 10-6	24,600	0.5	100 to 130	chill-cast
25	2.8	1050	19 to 20 × 10-6	24,600 to 31,400	0.5	110 to 130	chill-cast
26	2.8	1000	22 to 24 × 10-6	56,000 to 60,500	15 to 20	110 to 125	hot-pressed and aged
27 and 28				18,000			chill-cast
34	2.6	1050	17 to 19 × 10-6	22,400	1 to 2	80 to 90	chill-cast
35	1.8	930	24 to 25 × 10-6	24,600	1.5	85 to 90	chill-cast
				47,000	4.0	65 to 70	pressed

Bill Tells How Barrow Wheels Are Molded

By Pat Dwyer

WHILE pawing through the pages of an old scrap book the other night I came across a group picture of a gang with whom I worked about the time the new century was coming in. For the benefit and information of any carping critic who may be tempted to rise up and inquire caustically "Which century?" let me hasten to add I have reference to the present, our well known twentieth century.

In a general way I am familiar with the fact that large sections of the human race figure their time on a different basis. The Mohammedans begin with the hegira about the year 622 A.D., according to our system. According to the Hebrew calendar we are now somewhere between the 50th and 60th century—I have not the exact figure by me at the moment—anyway what are a few centuries among friends—and the Chinese—well, I guess the Chinese themselves are not quite sure when their history began.

Before closing the subject definitely, perhaps I may be pardoned for saying another word. From chance conversations and rumors that drift occasionally into my den I have learned that an impression prevails in some quarters that I had a hand in casting the first Liberty Bell during my apprentice days. This of course is a gross exaggeration. I served my time in a gray iron foundry. Trusting that the foregoing clears up all debatable points in a satisfactory manner, the reader can raise no further objection when I say that I was looking at a group picture taken when the new century was coming in—Oh, well, if you insist, the year was 1901 of the Christian era. At the time the picture was taken I do not think any member of the group was contemplating the severance of the ties which bound him to his job in that particular foundry, and yet, inside a year the whole gang, with the exception of one who is there at present, had disappeared and been replaced by others. At infrequent intervals during the first few years, I heard of or from two of these wandering birds of passage, but today I have not the faintest idea where any of them are with the exception of Bill. He and I left about the same time, but we traveled in different directions for many years until a fortuitous set of circumstances brought us together again here several years ago.

From an occasional hint in his conversation, or maybe a brief glint of the old wanderlust in his eye, I know he is not completely cured—and never will be cured until the old gent with the long beard, the scythe and the hour glass takes him for a ride. He is one of the great army to whom the ranges continually beckon.

Till a voice, as bad as conscience, rang interminable changes
On one everlasting Whisper, day and night repeated—so:
"Something hidden. Go and find it. Go and look behind the Ranges—
"Something lost behind the ranges. Lost and waiting for you. Go!"

When he dropped in to see me last night I showed him the picture and asked him if he remembered the different individuals. I found that his memory was better than mine. The faces of the men in the group were familiar to me, but the names of several had escaped me altogether. Bill not only remembered the names and faces, but he recalled the jobs each man was engaged on the day the picture was taken.

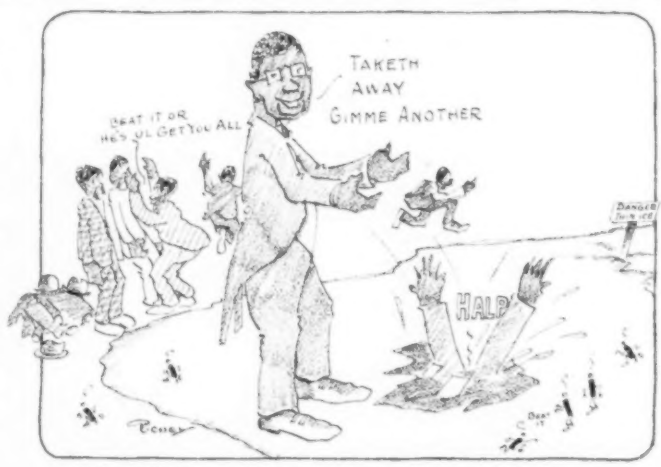
He admitted modestly to the possession of a fair memory—just fair to middling as you might say—but he laid no claim to omniscience. For example he could not recall whether the picture was made on the 9th or the 11th of August. Payday was on the 10th and he was not quite sure whether the picture was taken the day before or the day after. Basing his opinion on the fact that certain members were present, he was inclined to the opinion that the picture must have been taken on the 9th. Paydays, in those days, were paydays.

"Do you remember the day the new super came in?" Bill inquired.

"Which one? It seems to me they were coming and going all the time we were there."

"Well," Bill admitted with a grin, "the super mortality rate certainly was rather high for a while, but that is not unusual in a new plant. Looking back on those old days I am reminded of the colored minister engaged in baptising members of his flock through a hole in the river ice. He lost his grip on one candidate who was snatched by the current and whipped out of sight. The old lad was equal to the occasion.

"Beaming benevolently over the tops of his spectacles, he remarked piously: 'De Lawd giveth an' de Lawd taketh away. Pass me along anothah one!' "However, I am thinking now of the day Jim Stewart arrived and took a walk around the shop to familiarize himself with conditions. Back of the cupolas he paused for a few minutes to watch a colored gentleman leisurely shoveling slag and other refuse from the drop, into a wheelbarrow. When the barrow was about half loaded, the trusty henchman moistened his palms, rubbed them together to insure proper distribution, then grasped the handles and started away with



The Old Line: The Big Ones Always Get Away

his load. Jim was properly horrified. He was not going to permit that kind of soldiering to continue. He spoke to the colored gent.

" 'Hey, you!' sez he.

"The barrow man lowered his load and slowly turned around.

" 'Was you speakin' to me?' He inquired.

" 'Certainly I was speaking to you,' Jim said. 'That's no load for a wheelbarrow. Come back here and fill it up.'

"The man gazed at him in pained surprise. 'Fill it up? Man it is filled now all de full it's goin' to be filled.'

"So far as he was concerned the incident was closed with all the honors in his favor. He skilfully applied another dose of stickum to the palms and slowly stooped to grasp the wheelbarrow handles.

"Clearly this was a time for all good men and true to rally round and so forth. Enforce discipline and all that kind of thing.

" 'Just a minute,' says Jim. 'Do you know who I am?' The charioteer came to rest, but did not straighten up. He merely turned his head on a long neck through an angle of approximately 90 degrees and remarked carelessly: 'Man, Ah didn't come heah to make acquaintances. You, bettah travel along and 'tend to you' own business an' Ah'll tend to mine!' " "Yes," I said, "and before half an hour, the story was all over the shop. The cupola man, from his coign of vantage inside the cupola, had scooped enough of the daubing out of his ears to absorb the conversation. With sundry profane embellishments of his own he passed the good word on to his helper. The helper generously shared the news with a few men working near the cupola.

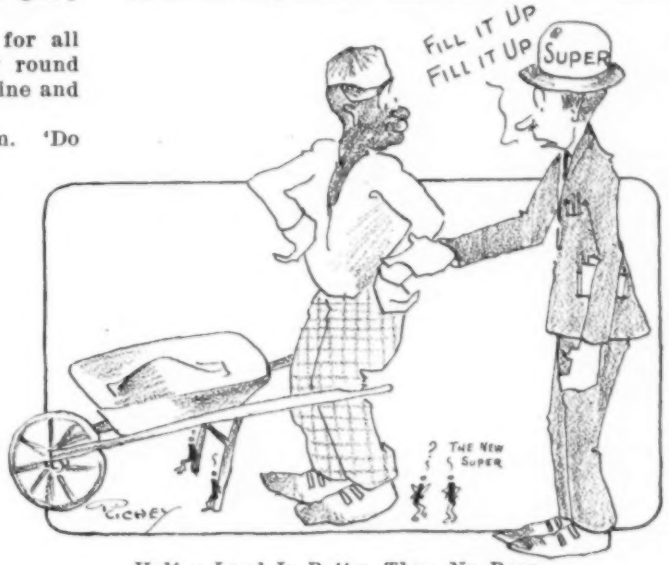
"For many days thereafter whenever one molder had occasion to pass another man's floor he would stop and inquire haughtily: 'Say, fella, do you know who I am?'

"The second lad would assume a crouching position, spread his fingers in a derisive gesture, cull some choice tid bits from his foundry vocabulary concluding with the familiar: 'Man, Ah didn't come heah to make acquaintance. You bettah fly to (deleted by censor) outa heah an' tend to you' own business an' Ah'll tend to mine.'

"This delicate bit of repartee never failed to bring a hearty laugh from the roughnecks in the gallery. Heigho, we were a light hearted gang in those far away days of our youth and laughed easily and often."

"What do you mean, far away days of our youth?" Bill asked, indignantly "We are only kids yet, compared to some of the real foundry veterans. I had a letter the other day from a master foundryman of other days, Robert Emmet Masters, who will be 82 next Christmas day. He retired from active service 20 years ago, but never has lost interest in the industry where he shone for so many years as one of the leading lights.

"A true craftsman and a pioneer in many lines, he freely shared the results of his investigations and discoveries through prolific contributions to the technical press and through private correspondence. This too, at a period when foundrymen preferred to remain coyly hidden in their shells and when writers on foundry subjects could be counted on the fingers of a one arm man.



Half a Load Is Better Than No Beer

"Something he read recently caused him to drop into a reminiscent mood and while in that condition he seized his trusty pen and dashed off the following epistle:

Dear Bill: From your published remarks now and again I gather in a general way that you are interested in statistics. Well, here are a few you might add to your collection. For over 40 years I averaged over 40 tons of gray iron castings per day. Now, how many train loads is that at 30 tons to a car load and 30 cars to a train?

These figures are conservative. I was engaged in the foundry business for 45 years, 40 of them as manager of plants in various parts of the country. Many of these plants conducted car wheel departments and the output of car wheel shops runs into real tonnage.

I have melted 150 tons of iron a day and have a record in print of 25,000 tons of castings per annum, including such miscellaneous lines as railroad castings, cotton and sugar presses, ice machinery and all kinds of general castings. The largest single casting I ever turned out weighed 70,000 pounds and all this at a time when bull strength and ingenuity had to serve instead of the present highly developed foundry mechanical equipment for nearly all purposes.

"That certainly is a remarkable record," Bill continued, "especially when you take into account—as he says—the period during which it was made. All the sand was rammed by hand and was transported around the shop in wheelbarrows. The standard old *Irish locomotive*—two starting bars and a single wheel—still is used to some extent in the foundry and apparently it enjoys wide popularity in many other fields. I had an inquiry the other day from a man who was thinking of making the wheels.

"He was planning to make steel barrow wheels with cast iron hubs, but had not decided whether to cast the hubs in a green sand mold or in a pair of dry sand cores. Of course they were not cores, properly speaking since they were designed to form the outside and not the inside of the casting, but you know how it is in the foundry, every hunk of artificially bonded sand formed in a corebox and dried in an oven is known as a core. He wanted to know what would be the cost of making a pair of these hub cores with sharp sand at $3.50 per yard and labor at $2.50 per day where (a) the cores are made by hand and (b) where they are made on a jolt machine. Each of these pairs of cores would require approximately 1 cubic foot of sand. A cubic yard contains only 27 cubic feet, therefore the sand alone in each pair of cores would cost almost 13 cents. To this must be added the cost of the binder, mixing and transporting the sand and the fuel for drying the cores. If a muller type of sand mixer is available the old cores can be reconditioned several times with a minimum addition of new sand, but under the most favorable conditions, each pair of cores will cost approximately 25 cents. Manifestly under these conditions, dry sand cores can not be considered as a competitive factor.

"Iron molds are employed in several foundries where cast iron hubs are applied to steel spoke wheels. However, supplementary equipment in the form of a hydraulically operated truing device is required after the wheels are cast to adjust casting strains, to bring the rim back to a circle concentric with the hub.

"A green sand mold made in an iron flask is the ideal method for casting iron hubs on wheelbarrow wheels. The initial equipment is expensive, but on a large production basis, this cost readily is absorbed. The equipment will last indefinitely and after the first cost is met, the

only operating cost is the cost of the labor and that is only a few cents per hub.

"One prominent wheelbarrow manufacturer operates a small foundry department for casting the hubs on the wheels. The rims are formed from flat strip steel which is punched for the spokes, bent to shape and the ends welded on a special electric welding machine. The ends of the spokes are inserted in the punched holes and welded in place. The hubless wheels then are taken to the foundry and stacked in the vicinity of the molding machine.

"This ingenious machine was designed and built by the company for this express purpose. Three stripping plate machines are mounted on a turntable which revolves around a high central pedestal. A bracket attached to the post supports a pneumatic squeezing head the diameter of the small iron flasks in which the molds are made. Duplicate patterns of a half hub and set of half spokes are mounted on each machine. The hub on the wheel is symmetrical, therefore cope and drag molds are alike with the exception of the gate which is placed on the hub of the cope mold. The small circular cast iron flask is provided with notches in the joint which fit over the spokes on the pattern. Small notches in five projecting lugs serve to locate the rim and spokes before the cope is placed on the drag. Machined male and female joints serve to locate the cope axially on the drag. A single pin dropped through corresponding lugs on the cope and drag, locates the cope circumferentially on the drag. Copes and drags are interchangeable.

"In practice, a flask is placed on the first stripping plate machine. It is filled with sand and the table is rotated one-third of a circle where an automatic stop locates the flask accurately under the squeezing head. The operator opens a valve which admits air to the cylinder. The plunger attached to the squeezing head is forced down and the head compresses the sand in the flask to the required degree of density. The head then is released and the table is rotated another third of a circle. At this point the pattern is dropped through the plate and the mold is removed and placed on the pouring platform.

"The table again is rotated a third of a circle and the pattern is raised into place. In the meantime of course, two other molds are on their way around the circle and the cycle is continued indefinitely, or rather until the day's work is completed.

"Four pouring racks are arranged in parallel lines. To conserve space, the inner pair are higher than those on the outside. The wheel rims in the high molds extend part way over those on the outside. This arrangement also facilitates clamping and pouring. The molds on the lower level are poured first.

"The pouring stands are formed of steel channels with short pieces of angles riveted in place to definitely locate the molds. A long bolt anchored to the channel extends upward between each pair of molds and passes through a short bar at the top. The ends of this bar rest on the top edges of two adjoining copes. A wing nut tightens the bar and effectually holds the copes in place during the pouring process. Each rack holds 72 molds

The foregoing description applies only to wheels with a single row of spokes laid parallel with the upper and lower edges of the rim. Dry sand cores in four sections furnish the most convenient medium for forming the hubs on wheels with spokes which enter the hub at different levels like those, for example, in a bicycle.

Nothing Safe. Even Milk Has a Kick To It

"If you want to juggle with statistics, there is something on which you can exercise your ingenuity. Just take round figures to make it easy. Assuming 300 wheels per day and 300 working days per year, we have enough wheels to equip 90,000 wheelbarrows. If placed end to end —highly improbable in fact, but no trouble in theory—and allowing 5 feet in length for each barrow, the line would extend for 81 miles. If each barrow was loaded with 300 pounds of material, the total would amount to 10,500 tons, a fair load for one of the big ore boats that ply the lakes."

"Maybe so," I said, "but they would not unload the boat in 4 hours, as the big Huletts do, down on the lake front. Have you ever heard the story of the lad who went to milk the cow? He came back with an empty bucket. The boss farmer angrily asked him if the cow did not give any. 'Yeah,' said the lad wearily, '9 quarts and a kick!' "

New Sales and Service Building Completed

Chicago Pneumatic Tool Co., 6 East Forty-fourth street, New York, recently completed a new service station for portable tools at 570 East Larned street, Detroit. The company maintains 20 similar stations throughout the country. The building contains approximately 12,000 square feet of floor space, has two stories and basement and houses the heavy machinery storage, parts storage, sound proof test room, offices, complete tool storage and repair, shipping, receiving and delivery departments.

Book Review

Practical Japanning and Enameling, by William J. Miskella, imitation leather, 250 pages, 6 x 9 inches, published by Finishing Research Laboratories Inc., Chicago, and supplied by THE FOUNDRY, Cleveland, for $3.65 and in London by the Penton Publishing Co. Ltd., 416-17 Caxton House, Westminster, for 17s 6d, postage extra.

This volume is the third of a series on metal finishes. It is designed to make available to those not familiar with finishing practice information that readily is understandable. The volume may be used both as a text book and as a handbook on baked finishing. It contains information on raw materials, methods, and equipment used in the japanning and enameling industries.

The first two chapters of the book deal with the difficulties that beset the pioneers in the industries and with the processes and finishes now in use. The following five chapters contain information on raw materials and include properties and uses of japans and enamels, reducers, putties and fillers, and baking varnishes. The next three chapters are devoted to sandblast equipment, cleaning equipment and preparation of surfaces. Methods of application of japans and enamels are the subjects for discussion of the following two chapters while oven equipment and methods of loading are dealt with in the next five chapters.

Chapter XVIII is devoted to hazards and fire prevention methods. The remainder of the book discusses lithographing ovens, water japan, mechanical decoration and the silk screen stencil process.

Crane Data Available

Whiting Corp., Harvey, Ill., recently published a book entitled *Crane Engineering*. The data for the publication was compiled by M. F. Beth-

am, one of the company's crane engineers. The material is in the form of a handbook of crane data and contains such information as how to select a crane, duty classification of all types of cranes, standard clearances for electric overhead traveling cranes, average range of speeds for all classes of duty, duty cycle analysis, etc. The book also explains details of construction and operation of various type cranes including the bucket-handling, gantry, traveling, jib, pillar and bucket types. Further information includes lifting attachments, electrical equipment for overhead traveling cranes, erection, lubrication, specifications and safety features. The book is well illustrated with both details and typical installations and contains many tables giving specifications.

Steel Foundry Casts Anvil Block

SIZE and capacity of forging hammers of various types have increased to a remarkable degree in recent years and as a result some of the castings entering into their construction have attained a limit which places them beyond the reach of all but a comparatively small number of foundries. Transportation is another important factor to be considered. The casting usually must be carried a considerable distance.

One of these outstanding steel castings, an anvil block of 230,000 pounds, recently was produced at the Lakeside plant of the Otis Steel Co., Cleveland. It was cast to the order of the Alliance Machine Co., Alliance, O., for use in the plant of the Taylor Forge & Pipe Works, Chicago. The sow block in the center, usually cast independently in castings of this character, was cast as an integral part of the anvil block in this instance. The drag part of the mold, to the left, and the casting to the right, are shown in the accompanying illustration.

This illustration also shows that the casting was molded and poured with the working face down. This is in the opposite position from that which it occupies when in use, or as it appears loaded on the railroad car for shipment from the plant of the Otis Steel Co. The flat bottom surface furnished an ideal location for the erection of suitable feeding or sinkheads.

A box type pattern with loose sections was employed to form the mold, which was rammed in sand inside a strong steel flask, made up of several sections. The mold was dried with gas burners where it rested in a concrete pit, specially designed for making molds for large castings. Suitable devices anchored near the top of the pit walls held the ends of the steel I-beams which in turn held the cope on the drag during the pouring operation. The sides of the flask were braced from the walls of the pit.

Approximately two weeks were consumed in preparing the mold for the reception of the metal. A total of 280,000 pounds of metal was melted in three furnaces and was tapped simultaneously into three ladles. With the ladles in position, the metal entered the mold through three runners, each 5 inches in diameter, located near the bottom, one at each end and one at one side. One of the gates may be noted between and slightly above the two trunnion cores in the far end of the mold. This gate is connected to a vertical sprue made up of a number of refractory sleeves, large in diameter, but similar to those employed in sheathing the stopper rod in the steel ladle.

Stripping the casting commenced three weeks after it was poured. The cope was removed first, then part of the drag and then the remainder of the drag and sand with an interval of three days between each stage. By that time the block was cold enough to work on and the risers were cut off with carbo-hydrogen gas.

Ten days were required to chip and clean the casting as it stood in the pit. Then it was turned over and the working face was cleaned. Solid trunnions on the sides and ends facilitated handling the casting with two cranes in the pit and later in the machine shop where the block was faced on both top and bottom. Due to the weight and size of the object, the necessary machine work occupied three weeks. In the preliminary estimate, nine weeks was given as the time required to deliver the casting and this time was beaten by a slight margin.

The casting is 6 feet wide, 7 feet high and 14 feet in length and with a weight of 115 tons is believed to be the heaviest steel casting made in Cleveland up to the present.

Fig. 1—(Left)—The Mold Was Made in a Flask and Dried in a Pit With Gas Burners. Fig. 2—(Right)—The Casting Was Loaded and Shipped on a Flat Car Specially Designed and Constructed for the Transportation of Heavy Loads

Each Casting Becomes A Salesman

THE Steel Founders Society of America, at its meeting at the Hotel Roosevelt in New York, Oct. 22-24, recommended the practice of molding into each casting the phrase *Cast Steel*. It has realized that many castings might be too small to permit this practice, or that it might be difficult due to certain cleaning or machining operations. However, it was believed that there would be little difficulty in connection with the vast majority of castings. The society is in position to supply metal strips with lettering in seven or eight different sizes. The cost, it was pointed, would be relatively small, the smaller strips costing around 2 cents each and the larger averaging around 4 cents a piece.

While the early outlook in the steel foundry industry is not promising, a gradual improvement is expected, according to opinions expressed at the meeting. While there may be flurries of activity in the near future little hope was held for substantial business much before spring.

New Uses Discussed

Major subjects discussed included new uses for cast steel, merchandising and trade customs. The first day was given over to committee meetings, while the second was devoted largely to general sessions, with a portion of the time allotted to meetings of both the large and the small castings divisions. A meeting of the heat-corrosion resistant alloy founders' division was held at the society's headquarters in the Graybar building on Friday morning.

The next meeting of the society will be held in Chicago, Dec. 12, and the January meeting will be held Jan. 25. A meeting also will be held in March with special sessions devoted to sales problems. This feature results from suggestions on the value of a conference for salesmen, which was made at a recent meeting of the group. It was announced that the society's membership had increased 60 per cent during the past year.

Preparedness for better days to come was stressed by W. H. Worrilow, Lebanon Steel Foundry, Lebanon, Pa., vice president and chairman of the eastern division of the society, who presided at the general sessions. He urged all members to take advantage fo the present inactivity to install such new equipment as may be badly needed. He is not in sympathy with "the buy it now" movement, asserting that in his opinion such artificial measures seldom accomplished much good. Discussion developed that the steel foundry industry generally is maintaining wage rates, although naturally having to reduce the number of working hours.

Has High Strength

Arthur Marks, engineer and metallurgist, Boston, discussed opportunities for the development of new uses for cast steel. He asserted that provided the design of the casting did not interfere, cast steel could well match the strength of forgings. The use of the x-ray in the foundry for spotting defects is becoming increasingly advantageous. It is now possible, he said, to detect defects in cast steel up to 1½ inches in thickness. A committee recently was formed which will meet monthly to discuss new uses for steel castings.

The business outlook was discussed by Marc A. Rose, managing editor of *Business Week*, New York, at a luncheon on the second day. He said there were two groups of thought with regard to recovery from the dullness. One believes that developments would have to run a natural cycle and the other feels measures can be taken for materially shortening the time of recovery. He personally was inclined toward the latter viewpoint.

Discussion of trade customs developed the fact that the code, recently approved by the society, has been accepted by approximately 60 steel foundries, of which 20 were nonmember companies and by approximately 75 consumers of steel castings. Various points in the code were discussed, with the possibility that at a later date there may be some minor revisions.

Need of the industry for higher standards of quality and for adequate equipment for maintaining these standards was emphasized by John R. Baush, foundry superintendent, Dodge Steel Co., Philadelphia. He said there were many foundries which did not have equipment sufficiently modern to keep abreast with demands being made upon the steel foundry industry, to say nothing of equipment that would permit them to keep ahead. He also declared there was need for better foundry technique and more rigid inspection.

Worthington Acquires Gilman Mfg. Co.

Worthington Pump & Machinery Corp., 2 Park avenue, New York, has acquired the Gilman Mfg. Co., East Boston, Mass., manufacturer of rock drilling equipment. The Worthington Company is expanding its line of pneumatic equipment to mines, quarries, contractors, etc. Equipment made by the Gilman company will supplement the line of air valves made by the Worthington company.

X-ray Uses Shown

The General Electric X-Ray Corp., Chicago, recently has published a 40-page catalog describing industrial uses of x-rays. Numerous illustrations of radiographs depict clearly the applicability of x-rays in revealing hidden defects in malleable cast iron, aluminum alloy, steel, brass and bronze castings, assembled products, and welded joints. The back portion of the catalog shows some installations of x-ray apparatus, and describes advantages of the equipment manufactured by the firm.

Sales Division Formed

Black & Decker Mfg. Co., Townson, Md., recently established a sales division for marketing high-speed, production tools, heavy duty grinders, swing frame grinders and snaggers and buffers. Those products will be sold under the name Black & Decker-Van Dorn and will be distributed through industrial jobbers. The company also has issued a catalog of the products mentioned under the new trade name. Curtis C. Watts has been made assistant sales manager of the new division.

Sales Manager Resigns

H. D. Gates, for a number of years connected with the Pangborn Corp., Hagerstown, Md., and in recent years sales manager of that company, has resigned his position. Mr. Gates expects to take a much needed rest before assuming a new connection after the first of the year.

WHAT OTHERS ARE THINKING

Abstracts Selected from the World's Foundry Literature

Refines Grain of Aluminum Alloys

Gas Removal and Grain Refinement of Aluminum Alloys, by W. Rosenhain, J. D. Grogan and T. H. Schofield, *Foundry Trade Journal*, London Sept. 11, 1930.

A large amount of work has been done in recent years on the presolidification treatment of aluminum and its alloys for the removal of gas. Rosenhain first developed the method of passing nitrogen through the liquid metal to eliminate gas and later Tullis used boron trichloride for the same purpose. The authors have conducted further experiments in that direction and have used carbon tetrachloride, silicon tetrachloride, titanium tetrachloride, tin tetrachloride, aluminum chloride, ferric chloride and tetrachlorethane. The latter compound was chosen to determine the effect of a material containing hydrogen.

The apparatus employed and the method of manipulation are described. The amount of chloride used, was divided into units based on the titanium in titanium tetrachloride and was that volume which contained 0.05 per cent titanium relative to the weight of metal employed. It was found that all materials used were capable of removing gas from the metal although in the case of tetrachlorethane slight signs of residual gas were discernible. Wide limit of experimental error produced by small amounts of the metal employed cast doubt on the relative efficiency of the various substances which were used in the experiments.

It was found the tin tetrachloride and ferric chloride contaminated the metal and altered the density. Silicon and carbon tetrachloride, tetrachlorethane and aluminum chloride gave practically the same density after treatment with various units. A 1-inch diameter, sand cast untreated, alloy bar is modified and contains dendrites of primary aluminum in a eutectic which is rather coarse. Treatment with any of the reagents mentioned, except titanium tetrachloride, progressive, destroyed the modified structure and caused reversion to the normal. Microexamination did not show any alteration in grain size with carbon or silicon tetrachlorides, tetrachlorethane, or aluminum or ferric chlorides. Titanium tetrachloride and to a lesser extent tin tetrachloride, produced a definite reduction in grain size.

A series of experiments also was carried out to find the affect of various elements on the grain refinement of aluminum. Aluminum in the unalloyed state, cast in sand, developed a relatively coarse structure which was disclosed by etching. That method was used to investigate the grain refinement of the elements chosen. The authors found that titanium was a grain refinement agent but gave an alloy with a lower density than virgin aluminum. Carbon and silicon did not exert an influence on grain size and experiments showed that thorium also did not. Tests also were conducted on other aluminum alloys both in the cast and the rolled form.

The following conclusions were reached: All chlorides are efficacious in removing gas from aluminum and its alloys and especially in silicon-aluminum alloys; titanium tetrachloride, in addition to removing gas, developes a fine grain in the metal; reduction in grain size is produced by the titanium and not by the chloride and persists after remelting; refinement in macrostructure is not accompanied by an alteration in microstructure in the alloys which were under observation.

Nonferrous Castings Used

The Use of Nonferrous Metals in the Aeronautical Industry, by Prof. D. Hanson, *Metal Industry*, London, Sept. 26, 1930.

Magnesium is produced by a process closely resembling that used for aluminum. Probably the greatest advance in the technology of magnesium has been the perfection of melting and casting methods. In other respects foundry practice is similar to that of aluminum.

Alloys of magnesium with iron, nickel, tin and lead have not shown useful properties. However, alloys of magnesium aluminum and zinc have excellent casting and physical properties and are fairly resistant to atmospheric corrosion. Copper, although not a major constituent of magnesium alloys, produces a strong and atmospheric corrosion resistant metal. Approximately 0.3 per cent manganese usually is added to magnesium alloys. That metal increases resistance to corrosion but has little effect on mechanical properties. Silicon present in sufficient quantities renders the alloy susceptable to hardening by heat treatment.

Magnesium and aluminum aircraft alloys compare favorably and sand cast show strengths similar to the latter alloys but are superior in specific strength. Little has been done on heat treatment of the former alloys but the AM7.5 alloy is capable of improvement.

Foundry methods for the production of magnesium alloy castings require careful control but such castings are easy to make and are practically free from pin-holing. The alloys may be used for pressure die casting but have not proved successful by the gravity method. Many aircraft castings are produced from magnesium alloys and include crank cases, cylinder castings, gear casings, carburetor castings, induction pipes and manifolds. That metal also is used in structural members for airplanes. Magnesium is inferior to aluminum in elastic modulus and in corrosion resistance.

Other metals used in aircraft construction include phosphor-bronzes and special bronzes. Tin, zinc, cadmium and nickel also are used. Nickel generally used in association with chromium, is used in the steels and in monel metal.

Transformation Points Studied

The Influence of Nickel on the Temperature of Metastable and Stable A_1 Transformation of Eutectic Iron-carbon and Iron-carbon-silicon Alloys (Der Einfluss von Nickel auf die Temperaturen der Metastabilen und Stabilen A_1-Umwandlung Eutektischer Eisen-Kohlenstoff und Eisen-Kohlenstoff-Silizium-Legierungen), by A. Merz and F. Fleischer, *Die Giesserei*, Dusseldorf, Germany, Aug. 22, 1930.

The base alloy used by the authors was a eutectic iron-carbon alloy made from pure electrolytic iron and sugar carbon which was melted in a Tamman furnace under careful controlled conditions of temperature and cooling. The alloy contained 4.17 per cent total carbon, 2.62 per cent graphite, 0.038 per cent silicon, 0.015 per cent manganese, 0.009 per cent phosphorus and 0.007 per cent sulphur. To that alloy 1 to 3 per cent nickel; 1 to 3 per cent nickel, 1 to 3 per cent silicon; and 1 to 3 per cent silicon without nickel were added.

The conclusions arrived at by the authors are: (1) The dependence of the position of the transformation temperature from the test velocities used is linear. (2) The position for the velocity of 0 degrees per minute ascertained for that metastable A_1 transformation temperature showed a linear reduction of 12 degrees for each 1 per cent nickel. The transformation temperature increased with the addition of silicon but the rise became less for increasing amounts of that element. About 2 per cent nickel makes the temperature decrease effect more noticeable with silicon bearing alloys Hysteresis was increased through increasing nickel and silicon contents of the alloy.

The temperature plant of the metastable A_1 temperature depending on the nickel and silicon content, takes a continuous course. (3) After suitable heat treatment to establish the stable condition, an investigation of the stable A_1 transformation temperature showed a linear increase of the same of about 31 degrees for each 1 per cent silicon and a linear decrease of about 12 degrees for each 1 per cent nickel. Also the temperature plane of the stable A_1 transformation takes a continuous course and lies above that of the metastable. (4) The investigational work carried out on the position of the graphite eutectic confirms its existence.

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¶ When Castings Are Best

IN AN address to the incoming freshman class, the president of a large engineering college said that the present problem of adjusting consumption to output resolved about research in merchandising. He said that science has made great steps in harnessing the forces of nature to the usefulness and convenience of man, but that merchandising has not kept step with scientific advancement. He blames that factor for the present period of depression.

MERCHANDISING has been neglected, although the invention of machines that reduce the unit cost and lower the sales price has gone ahead with rapid strides. The foundry industry has not been found wanting in the adoption of machinery. It has reduced costs materially by the adoption of mechanical contrivances. However, merchandising has not been studied vigorously. The term does not mean the substitution of one class of castings for another. That line of endeavor simply transfers activity from one division of the industry to another and leads to reprisals that weaken the whole industry. The solution lies in the search for new uses and new products.

THERE are places where castings are more fitted to the construction of machines than any other material and research should reveal other uses. Certain classes are more fitted for some purposes than others. Intensive commercial research for new products and uses will build up the foundry industry.

¶ Good Men Waiting

WITH the dawn of better business conditions, apparently not now so remote, many changes in personnel undoubtedly will occur. In the foundry industry, executives who have not been exactly fitted to their responsiblities or those who have been on the casual list due to slack business will be seeking new connections. Many of the latter already are casting about, inquiring among their friends, answering help wanted advertisements and making personal contacts in an effort to find work suited to their ability and ambition.

MANY of these men would be of valuable assistance to the industry, when castings demand advances. Some could fill newly created positions or could replace those men who also desire to make a change. The managements of other foundries may exercise their discretions at this time to bring into the organizations men whom they believe to be better fitted for certain positions than the present incumbents. This is an era of change. Better equipment, revamped methods and proper executive management all will play a part in rebuilding business when the tide turns.

¶ Backing Up a Slogan

ONE of the points considered at a recent meeting of the Gray Iron insitute was the adoption of a statement or slogan descriptive of the merits of gray iron. A commendable move. Public opinion is a reflection of those statements or points which are quickly seen and easiest remembered. However, another plan of the institute which will serve to back this slogan idea is the decision to study the product, gray iron castings, and provide that members shall furnish castings worthy of the slogan. This is not only commendatory, but necessary. A good slogan is an asset when the product that it represents is worthy.

¶ Marking the Product

MERCHANDISING problems constitute one of the most important phases of the work of many trade associations. Committees constantly are at work studying ways and means of bringing a particular product to the attention of the buying public. This situation is true of the trade associations in the foundry industry.

THE adoption of a recommendation of the merchandising committee of the Steel Founders Society of America at the recent New York meeting, marks an important step in the program of that group. In the future, the words *Cast Steel* will be molded and cast on every casting produced by a member of the society. Metal strips in various sizes will be provided at a low cost by the society, so that letters used by the members will be uniform.

THE society now is going to tell the world about its product. Every casting that is placed in use becomes a salesman. Engineers, designers and the public in general will observe the value of steel castings as an engineering material. This program will assist in building a casting consciousness and ultimately will lead to a greater demand for the product.

Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

E. S. BLACK has been appointed research engineer, Pettibone-Mulliken Co., Chicago. For a number of years he was with American Manganese Steel Co., Chicago Heights, Ill., in the sales department and as assistant to the president. He also was connected with Page Engineering Co., Chicago, in a like capacity, and for a long period was identified with Hoover & Mason, Chicago, contracting engineers, designing and installing automatic ore handling machinery. Mr. Black was one of the pioneers in introducing manganese steel in rolling mills.

James Corey, safety director, Continental Roll & Steel Foundry Co., Wheeling, W. Va., recently was named director of the Wheeling Safety council.

James C. Brady has been elected a director of United States Pipe & Foundry Co., Burlington, N. J., to fill the vacancy caused by the death of Nicholas F. Brady.

Dr. D. J. McAdam Jr., naval engineering experiment station, Annapolis, Md., has been appointed chief of the section on metallography, bureau of standards, Washington.

Joseph H. Frantz, vice chairman of the board, American Rolling Mill Co., Middletown, O., has been elected a director of Buckeye Steel Castings Co., Columbus, O., to fill the unexpired term of the late Talfourd P. Linn.

G. V. Fern, Springfield, O., has purchased the controlling interest in the J. B. Foote Foundry Co., Fredricktown, O., and has succeeded F. B. Zeig as president of the firm. Mr. Zeig will continue on the board of directors.

Julius Goslin, Goslin-Birmingham Mfg. Co., Birmingham, Ala.; Watt L. Moreland, Moreland Motor Truck Co., Los Angeles; G. M. Williams, Marmon Motor Car Co., Indianapolis; and W. Hume Logan, Logan Co., Louisville, Ky., have been elected vice presidents of the National Association of Manufacturers in their respective states.

Willard H. Dow, formerly assistant general manager and a member of the board of directors, Dow Chemical Co., Midland, Mich., has been appointed president and general manager to succeed the late Dr. Herbert H. Dow. Mr. Dow was graduated from the University of Michigan with a B. S. degree in chemical engineering in 1919. He has been a member of the board of directors for the past 8 years, assistant general manager for 4 years and assistant treasurer for 3 years.

Edward James Brady Jr., formerly connected with the Burnside Steel Foundry Co., Chicago, recently became associated with the Sivyer Steel Casting Co., Milwaukee, in the research department. He was graduated from the University of Illinois in 1928 and immediately became affiliated with the Burnside company. Mr. Brady comes of a family that has been connected with the foundry industry for many years. His grandfather, James A. Brady, was the founder of the James A. Brady Gray Iron Foundry, Chicago, and his father is owner of the Midway Pattern Co., Chicago.

Newark Group A.S.M.E. Hold Joint Meeting

The regular monthly meeting of the Newark Foundrymen's association was held in conjunction with the metropolitan section of the American Society of Mechanical Engineers, Oct. 22, at the Downtown club, Newark, N. J. George E. Hagermann, associate editor, Alexander Hamilton institute, New York and formerly engineer, Warren Foundry & Pipe Co., Phillipsburg, N. J., described in an illustrated talk the manufacture of what is thought to be the largest pipe ever cast. E. T. Bennington, general sales manager, tramrail division, Cleveland Crane & Engineering Co., Wickliffe, O., outlined modern methods of overhead handling of materials in foundries.

Mr. Hagermann substituted for John Tirrell, general foreman of the Warren company who could not be present because of illness. He described pipe cast for a conduit tunnel 614 feet long for the New York Telephone Co. which now is being laid under the Harlem river at 127th street and Second avenue, New York. The castings were made by the Warren Foundry & Pipe Co., Phillipsburg, N. J. and are of the bell and spigot type. The job included two reducers, 105 to 84 inches in diameter, with spigot ends; eight 84-inch diameter curves, 6 feet long; and a number of 12-foot lengths 84 inches in diameter. The tunnel is composed of 64 sections of pipe and fittings.

According to the speaker, the pipes were poured with the bell end up. While mold and core ovens, casting pits and material handling facilities were ample, it was necessary to adjust certain equipment to the unusually large size of the work. Flasks, corebars and patterns were made especially for the job. Ramming machines used for regular pipe were designed to work up to 60 inches inside diameter. Hence, it was necessary to ram the 84-inch pipes by hand.

Flasks were built in sections. They were split on the diameter and were molded and cast in the floor of the green sand foundry. Core barrels for the straight pipe were cylindrical castings, and heavy spiders were riveted into each end to carry the journals. Core barrels and assembled flasks were approximately 14 feet in length overall. Chill plates, on which the flasks were mounted, were cast in green sand. Sweeps were used to make the cores for the reducers and curves. The body pattern, used for straight pipe molds, was a cast iron cylinder, provided with a heavy eyebolt in the top for lifting, and machined to fit accurately into the socket at the bottom of the flask. The socket was used to center the pattern during the ramming process. Sweeps were used to make the bead projection on the spigot end of the pipe. A wooden body pattern was used in molding the curves. Reducer molds were swept. Flasks were rammed by hand. The bell section was formed by split patterns inserted around the body pattern at the top of the mold.

Cores were made on the regular core machines. The journals in the ends of the core barrel rested on rollers and the barrel was revolved by a motor-driven mechanism at the end of the machine. A layer of hay rope was run on the barrel which was followed by loam. The coating on the bar was trued to size against a stationary strike board. The strike board also formed the core for the lead groove in the bell. Cores were set on racks carried by trucks and baked in the core ovens. They then were removed and placed in the flasks, being centered by the chill plate at the bottom of the flask. Pipes were poured with two ladles. Two separate pouring basins were formed at the top of the flask, each taking in half the circumference. A 7 and a 5-ton ladle were used. Two tons of iron first were poured from the 7-ton ladle, after which both ladles were poured.

After the pipes were poured and had cooled partially, the core barrels were withdrawn, the sections of the flask removed, and chains slung around the pipes. The pipes then were lifted from the pit by crane, chipped, coated with tar, tested and inspected.

OBITUARY

Robert H. Thorne, founder and president, Darling Valve & Mfg. Co., Williamsport, Pa., died at his home Oct. 27, following a month's illness. He was born in Oil City, Pa., July 26, 1863 but spent his boyhood in Fairview where he attended the public schools. His first position was that of telegraph operator for the Standard Oil Co. at Pine Station. He went to Williamsport in 1885 as secretary

Photo Blank-Stoller

Robert H. Thorne

to the superintendent of the Williamsport branch of the Standard company. Mr. Thorne organized the Darling Pump & Mfg. Co. in 1888 and became general manager. The business was reincorporated in 1896 as the Darling Valve & Mfg. Co. and Mr. Thorne was elected president, a position he held until his death. He was active in both social and civic matters and was a director of the Manufacturers club, Philadelphia and the Pennsylvania Manufacturing association.

James Anderson, foundry superintendent, R. Hoe & Co. Inc., Dunellen, N. J., died at his home in Elizabeth, N. J., Oct. 20. He was born in England and came to the United States 45 years ago.

Adolph F. Gartz, 68 years old, former treasurer Crane Co., Chicago, died Oct. 29 in Altadena, Calif., where he had moved several years ago. A native of New York, Mr. Gartz went to Chicago at 26, joining the Crane Co. He also was civil service commissioner for Chicago at one time.

William H. Holmes, for many years connected with the foundry industry, died at Franklin, Ind., Oct. 25. He was born in Indianapolis and was employed at various times as foundry superintendent at Purdue university, Lafayette, Ind.; American Foundry Co., Indianapolis; Wheland Machine Works, Chattanooga, Tenn.; and the Atlas Engine Works, Indianapolis. He was president of the Enterprise Foundry & Fence Co., Indianapolis, for a number of years. He also served as president of the Indiana Foundrymen's association. He had been in ill health for several years.

William Piez, European correspondent, Link-Belt Co., Chicago, died in Brussels, Belgium, Nov. 2. He was 52 years of age and was born in Newark, N. J., in 1878. He had lived in Paris since 1928 where he was European correspondent for the Link-Belt Co. Formerly he was district manager, Concrete Steel Co., Chicago. His brother, Charles Piez, is chairman of the board of directors, Link-Belt Co.

P. D. Schenck, president of the Duriron Co. Inc., Dayton, O., since its inception 15 years ago, and an authority on acid and corrosion resistant metals, died Oct. 15. Following his graduation, from Sheffield Scientific school, Yale university, he became associated with the Dayton Malleable Iron Co., Dayton, O., where he rose to the presidency. While employed by that company, he conceived the ideas leading to the development of the acid-resistant metal made by the Duriron Co. During the war, he served as a captain in the signal corps and supervised the inspection of material being manufactured in the middle-west for the government.

E. J. Campion, superintendent, Canadian Steel Foundries Ltd., Montreal, Que., died in Cleveland, Oct. 15. He was born in Lowell, Mass., May 31, 1878 and entered the employ of the Nashua Iron & Steel Co., Nashua, N. H., when he was 16 years of age. In 1897 he became connected with the Benjamin Atha Steel Co., Newark, N. J., as open-hearth melter. He resigned that position in 1906 to become open-hearth superintendent, American Steel Foundries, Inc., Franklin, Pa. Several years later, he resigned that position to start the operations of the open-hearth department of the Ontario Iron & Steel Co., Welland, Ont., a subsidiary of the Canadian Steel Foundries Ltd. A short time later he became open-hearth superintendent, American Steel Foundries, Chester, Pa., but resigned that position in 1917 to become assistant superintendent, Canadian Steel Foundries Ltd., Longue Pointe works, Montreal. Later he

E. J. Campion

was appointed superintendent, a position he held until his recent death.

Only Iron Pipe

THE following news dispatch from Monroe, Wis., contains information of interest to the foundry industry:

The common council of Monroe, Wis., has adopted an ordinance providing that in the future only iron sewer pipe be laid on any new installation and that when a street is paved, property owners be required to relay tile pipe laterals, using iron pipe. The action is the result of the difficulties experienced from root troubles, street department employes being constantly at work on sewer stoppages caused by this trouble.

Sand Handling Discussed

A. G. J. Rapp, in charge of the engineering department, National Engineering Co., Chicago, addressed the first regular meeting of the 1930-1931 association year of the Pittsburgh Foundrymen's association, held at the Carnegie Institute of Technology, Pittsburgh, Oct. 20. About 90 foundrymen attended the meeting. Mr. Rapp presented an interesting discussion on the importance of proper sand preparation in handling systems.

Publishes Bulletin

The bureau of standards recently has published a bulletin containing data on the American national standard screw threads, coarse and fine. The data given constitute commercial standard CS24-30, and copies of the bulletin may be obtained from the government printing office, Washington, D. C., for 10 cents.

Fuller Lehigh Co., Fullerton, Pa., has moved its Cincinnati offices from the Traction building to the Carew tower. H. E. Martin is in charge.

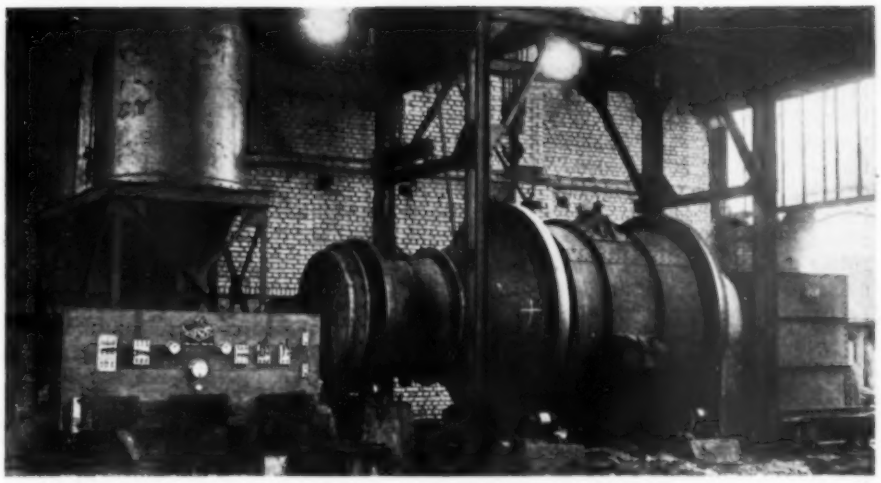
Radiator Castings Are Cleaned by Machine

Parsons Engineering Corp., 6536 Carnegie avenue, Cleveland, recently has made several installations of new automatic machines for the cleaning and brushing of radiator castings. One installation at the Federal Radiator Co., Zanesville, O., has a capacity of 6000 castings in an 8-hour shift with 3 operators. The machine knocks out the cores and cleans sand and chaplets from the face of the castings.

It is composed of four parts: Knockout section, first brushing unit, turn over, and second brushing unit. The units are so placed that dust can be collected. The method of handling castings in the knockout section is as follows: The hub of the radiator loop is placed over a pin bolted to a cross bar, which in turn is bolted at each end of a roller conveyor chain. The opposite hub of the loop is dragged over a series of gray iron bumps carried on a continuous apron conveyor moving in the opposite direction. The core sand flows out of the rear hub and is directed by hoppers into a mechanical conveying system.

Each section of the brushing machine is composed of two brush heads, individually driven by belts from ball bearing motors. Brushes are mounted on a steel shaft carried in ball bearing trunnions and secured by special hangers. Each brush head may be adjusted to compensate for wear on the brushes while the machine is in motion. That adjustment is made with a hand wheel which is mounted at an angle. Castings are conveyed under the brushes by a steel apron conveyor or protected rubber belt. Chaplets are knocked off the castings by chains mounted on motor driven drums before they enter the brushing unit..

The turnover section between the brushing units is made of specially formed steel plates arranged so that the radiator castings will slide downward by gravity at just the proper speed to turn over automatically. The complete machine, shown in the accompanying illustration, may be operated by three men and will clean 12 castings per minute. Control equipment includes a master switch which controls all motors, and three emergency push button switches at various points on the machine. Ten motors ranging from 2 to 25 horsepower drive the equipment. Control is compactly and centrally located near the mid-section of the machine. Switches are of dustproof construction.



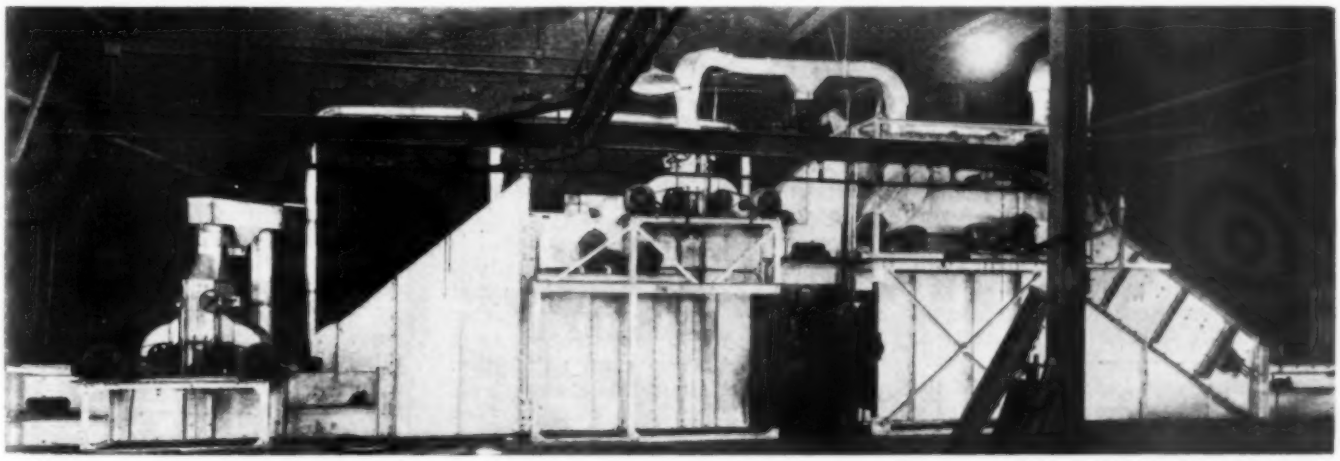
Five-Ton Powdered Fuel Burning Furnace Is Rotated by an Endless Chain Around the Circumference at One End

Rotary French Furnace Uses Powdered Fuel

After an extensive series of experiments to adapt pulverized coal firing to the cupola, the Societe des Entreprises Speciales de Chauffage Industriel, Paris, France, developed a mixer to be used in conjunction with the cupola. Later it was found that the mixer could be used in melting gray iron and following a series of modifications, the rotating powdered coal fired furnace shown in the accompanying illustration was evolved. The furnace is cylindrical and is built up of boiler plates, angles, cast steel rings and end plates. The rings at either end are supported on rollers to permit rotation. The furnace is rotated by an endless chain around its circumference at one end. The chain is driven by an electric motor and a special reversing switch attached to the motor permits rotation in either direction from 20 to 360 degrees.

Fuel for the furnace is pulverized in an atomizing mill provided with vitrified ceramic rollers which reduces the coal to a fineness that 98 per cent will pass through a 200-mesh sieve. The powdered coal is carried by a cyclone blower from the mill to the bins shown at the left of the illustration. The coal in the bins falls on an electrically-driven, double-screw distributor which feeds the coal into the hot air pipe. The intimately mixed air and fuel then passes into the burner which forms the left end of the furnace. It is claimed that the burner is arranged so that complete combustion takes place before the fuel reaches the melting chamber of the furnace.

The hot gases emerging from the opposite end of the furnace are collected in the movable chamber shown at the right of the illustration which directs them to an air preheater



The Machine Removes Molding and Core Sand, Chaplets and Gives the Castings a Semifinished Appearance

composed of metallic tubes. Air for combustion circulating around the tubes is said to acquire a temperature of 1100 degrees Fahr. A system of valves and by-passes are arranged to maintain the necessary temperature equilibrium. It is claimed that the preheating results in a 20 per cent economy. The movable chamber is mounted on roller guides so that it may be moved aside during the charging of the furnace. For charging the furnace, the makers have developed two types of equipment. For the small furnace the charging apparatus is similar to that for charging open-hearth furnaces. For the larger furnaces a belt conveyor cooled with water tubes is used. It is claimed that with either of the devices the furnace can be charged in 15 minutes notwithstanding furnace temperature.

It is said that a temperature of 3270 degrees Fahr. can be reached in the furnace which permits pouring the metal at 2900 degrees Fahr. The high temperature is stated to result in complete dissolution of the graphite and give a fluid metal for pouring thin castings. Oxidation is practically nil. Consumption of fuel is about 16 per cent for pig iron containing 2.5 per cent carbon, 1 per cent silicon, and cast at 2900 degrees Fahr.

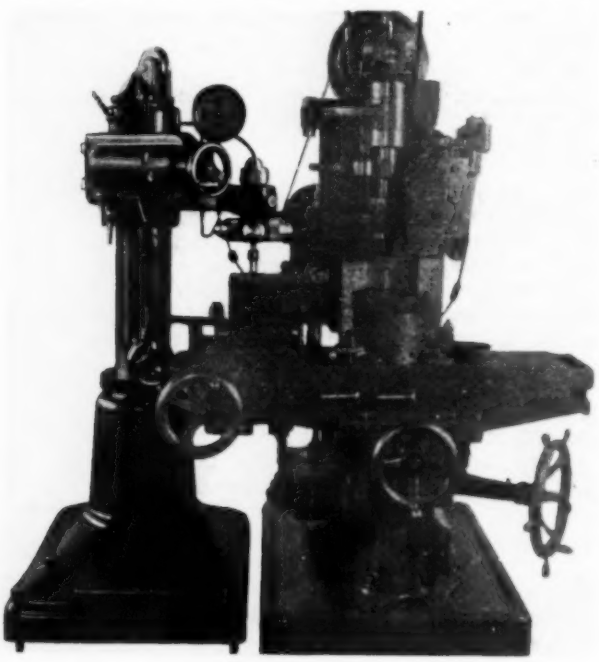
The furnace is lined with refractory brick and a rammed lining composed of clay composition containing 95 per cent silica. The brick are placed next to the shell. In lining the shell is suspended vertically in the steel framework shown above the furnace in the illustration.

The St. Louis district office of the Sterling Wheelbarrow Co., has been moved from 815 North Tenth street to 4239 Duncan street. O. E. Steep is district manager.

Miller Converted Into Die-Sinking Machine

Walcott Machine Co., Jackson, Mich., recently has placed upon the market a new transcribing machine adaptable to metal pattern work. The machine is designed for use with milling machines converting them into die sinking machines. The profiler is mounted on casters so that it may be moved from one machine to another in the shop. In operation the profiling machine is placed at the side of the milling machine. The plaster form of the die to be cut is mounted on the table of the miller at the left side of the spindle and lined up with the die block by pointers inserted in the transcribing instrument and in the head of the milling machine.

A cutting tool is inserted in the head of the milling machine and a *follow button*, corresponding to the form of the cutter, is fixed in the head of the transcribing machine. The milling table is adjusted so that the cutting tool is about .004-inch above the face of the die block and the arm of the instrument is set so that the follow button just touches the top face of the plaster mold. The table of the miller is adjusted so that the *follow button* comes in contact with the pattern. When so adjusted, the milling cutter cuts the die following the contour of the plaster model.



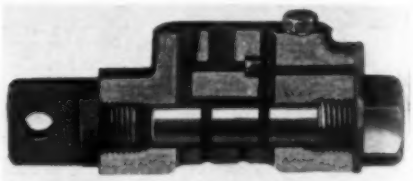
The Transcribing Instrument May Be Attached to the Milling Machine

The transcribing machine is equipped with a signal system which shows the operator the direction that the cutter should be fed. One plaster die is said to be satisfactory as a guide in making as many as 50 dies. Where larger quantities are required, the first die made is recommended as a guide. The instrument also is adaptable to knee type and vertically moving head milling machines.

Specifications of the instrument are as follows: Center of instrument to center of column, 14 inches, minimum, 38½ inches maximum; bottom of instrument chuck to floor, 32½ inches minimum, 61 inches maximum; floor space required, 32 x 43 inches; and weight, 2500 pounds.

Valve Type Vibrator Has New Features

Berkshire Mfg. Co., 1101 Power avenue, Cleveland, recently developed a new valve type vibrator which may be used on match plates, molding machines, benches, sand chutes, etc., for intermittent or continuous operation.



The Plunger Returns To the Starting Position Automatically

The feature of the vibrator is the absence of a spring to return it to the starting position. Claims made for the machine include positive starting, reliable action, economy and long life.

The vibrator consists of the outer casting, plunger, valve and spring, hex head and plate head. The vibrator operates in the following manner: Air enters the intake port and the pressure operated against the valve which opens and allows the air to flow behind the plunger and thus drive it forward. The plunger, in moving forward, shuts off the air supply from the starting side and exhausts remaining air at an outlet port. The plunger is operated in practically the same manner at the opposite end and the air is exhausted through another port.

The valve, previously mentioned has a small outlet around its stem which operates when the air pressure is turned off to bring the plunger back to the starting position. The air pressure in the opposite end of the cylinder forces the plunger back to the starting position and the air in that end of the cylinder is exhausted through the outlet in the valve stem.

The machine is made in two types which include match plate vibrators of ½, ⅝, ¾, and 1-inch sizes and two bolt table vibrators of 1¼, 1⅝ and 2-inch sizes. The smallest size weighs 1 pound 3 ounces and the largest 26 pounds. Air consumption varies from 1½ to 17 cubic feet per minute at 80 pounds line pressure. Vibrations per minute vary from 4875 to 2500 per minute.

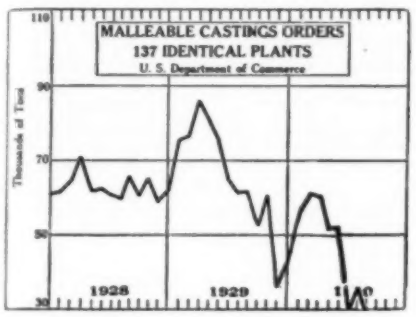
E. W. Balding, New York Belting & Packing Co., New York, sailed for Europe recently on the S. S. Caronia.

Trade Trends in Tabloid

BUSINESS activity in general has shown little change during the past 30 days. Preliminary statistics for October indicate about the same trend as in September. Several of the larger industries suffered recessions in October, while other factors are entirely too spotty to indicate trends.

—T—T—

Reports from various sections indicate that foundry operations on the



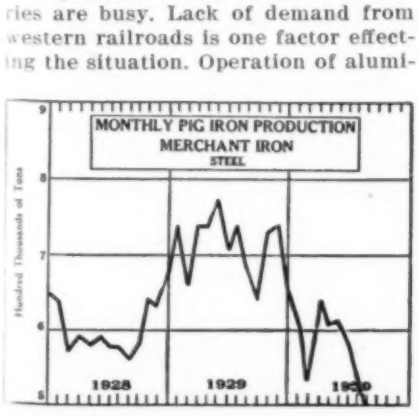
whole have maintained the level of September or have shown improvement. Sentiment appears to be strengthening among foundry operators.

—T—T—

Gray iron foundry operations in the Pittsburgh district declined slightly during the past 30 days, but improvement in schedules of malleable and steel shops brought the average for the industry slightly above the September level. Many gray iron foundries are not running more than three days a week on jobbing work and a number of industrial plants operating foundries are busy only two or three days a week. Steel foundry operations vary from 50 per cent to full time, with the general average better than 60 per cent. Steel mill equipment builders continue with full schedules.

—T—T—

Brass foundries in Chicago district were operating about three days a week at the close of October. This rate is slightly under that maintained in September. However, a few foundries are busy. Lack of demand from western railroads is one factor effecting the situation. Operation of aluminum foundries have picked up a little recently.



—T—T—

Pig iron production took a dive in October, with a decline of 8.2 per cent on a daily basis, according to *Steel*. October's daily rate was 69,851 gross tons compared with 75,893 tons in September. However, merchant iron production registered a slight gain, with a total of 414,913 tons produced in October, compared with 411,154 tons in September.

—T—T—

The past fortnight has witnessed increased activity in the railway car market. In addition to the 2000 cars previously reported as purchased by the Baltimore & Ohio, the Pennsylvania has awarded 1500 gondolas to its own shops, and the Santa Fe has issued an inquiry for 1560 cars, which it is believed may eventually reach 2500 cars.

—T—T—

Foundries in the St. Louis district specializing in stove and heating castings have received increased orders during the past few weeks, but shops supplying castings for the automotive and car building industries are slow.

—T—T—

Cast iron pipe inquiry is slightly heavier in the east, with pipe foundries reported operating at approximately 60 per cent of capacity.

—T—T—

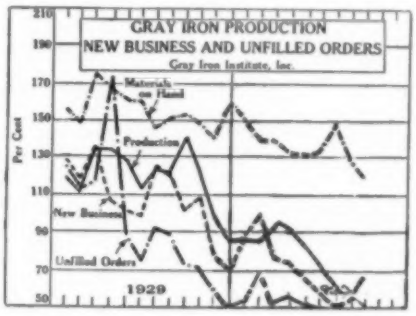
Orders for steel castings dropped again in September, total bookings for the month totaling 49,618 tons compared with 50,516 tons in August according to the department of commerce.

—T—T—

Loading of revenue freight cars for the week ended Oct. 25, totaled 959,335 cars, which is 28,250 over the previous week and 175,025 under the same period last year.

—T—T—

Foundry operations in the Chicago district average about 50 per cent. Several gray iron jobbing plants have had some increases in orders, while steel foundries have dropped off from the spurt in activity during September. Farm implement foundries' schedules are variable, the average being about three days a week. Stove foundries continue fairly busy.



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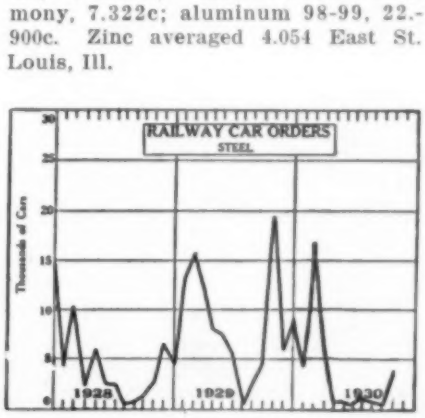
In September, for the first time in 6 months, the production of gray iron castings, as reported by the Gray Iron institute, showed an increase over the previous month. Production for September was given as 65.7 per cent of normal, compared with 62.8 per cent in August and 140.1 per cent in September, 1929. Normal is the average monthly production during the last three calendar years.

—T—T—

Average New York prices of nonferrous metals during October, according to *Daily Metal Trade*, were as follows: Casting copper, 9.702c; electrolytic copper 9.837c; Straits tin, 26.842c; lead, 5.125c; antimony, 7.322c; aluminum 98-99, 22.900c. Zinc averaged 4.054 East St. Louis, Ill.

RAW MATERIAL PRICES
November 5, 1930

Iron	
No. 2 foundry, Valley	$17.00
No. 2 Southern, Birmingham	14.00
No. 2 foundry, Chicago	17.50
No. 2 foundry, Buffalo	17.50
Basic, Valley	17.00
Basic, Buffalo	17.00
Malleable, Chicago	17.50
Malleable, Buffalo	18.00
Coke	
Connellsville beehive coke	$3.50 to 4.85
Wise county beehive coke	4.25 to 5.00
Detroit by-product coke	8.50
Scrap	
Heavy melting steel, Valley	$14.00 to 14.50
Heavy melting steel, Pitts	13.50 to 14.00
Heavy melting steel, Chicago	10.50 to 11.00
Stove plate, Buffalo	9.50 to 10.00
Stove plate, Chicago	6.50 to 7.00
No. 1 cast, New York	8.00 to 8.50
No. 1 cast, Chicago	10.50 to 11.00
No. 1 cast, Philadelphia	13.50
No. 1 cast, Pittsburgh	13.00 to 13.50
No. 1 cast, Birmingham	11.50 to 12.00
Car wheels, iron, Pittsburgh	14.00 to 14.50
Car wheels, iron, Chicago	12.50 to 13.00
Railroad malleable, Chicago	12.50 to 13.00
Agricultural mal., Chicago	11.00 to 11.50
Malleable, Buffalo	14.00 to 14.50
Nonferrous Metals	**Cents per pound**
Casting, copper, refinery	9.62½
Electro, copper, producers	10.00 to 10.12½
Straits, tin	27.00
Aluminum, No. 12, producers	22.00
Aluminum, No. 12 remelt	13.50
Lead, New York	5.10
Antimony, New York	7.37½
Nickel, electro	35.00
Zinc, East St. Louis, Ill.	3.95 to 4.00



What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

Knox Stove Works, Knoxville, Tenn., recently added two new products to its line of heaters and ranges.

Monroe Steel Castings Co., Monroe, Mich., recently suffered a slight damage by fire.

The foundry of the Rowan Foundry & Machine Works, Salisbury, N. C., has been discontinued.

E. C. Miller Foundry, Albermarle, N. C., has been purchased by A. D. Monroe and the name has been changed to the A. D. Monroe Foundry.

Standard Semi-Steel Foundry Co., 200 East Chase street, Springfield, Mo., has changed its name to the Standard Electric Steel Castings Co.

Wapak Hollow Ware Co., Wapakoneta, O., plant may be acquired by George Trautman, Sidney, O., for the establishment of a foundry.

Mooresville Foundry & Machine Shop, Mooresville, N. C., is adding melting equipment to its foundry, B. S. Houston is manager.

American Brake Shoe & Foundry Co., 230 Park avenue, New York, proposes to build a steel mill and foundry at Quebec, Que.

C. H. Turner Mfg. Co., Statesville, N. C., which has been shut down for some time, plans a reorganization and will open in the near future. C. H. Turner is president.

E. H. Bardes Range & Foundry Co., 2519 Colerain avenue, Cincinnati, will build a plant addition, 52 x 106 feet. Kruckmeyer & Strong, St. Paul building are the architects.

Spring City Foundry Co., Waukesha, Wis., has awarded several contracts through Frank D. Chase, 720 North Michigan avenue, Chicago, for a one-story foundry addition, 100 x 100 feet. (Noted Nov. 1.)

Charlotte Pipe & Foundry Co., Charlotte, N. C., recently suffered a severe loss by fire estimated at $100,000. It is reported that rebuilding operations will start soon. According to information, the new plant will be larger than the damaged plant.

Tallman Brass & Metal Co., Sanford avenue and Wilson street, Hamilton, Ont., is reported to have acquired a new plant and to be planning the installation of equipment for the manufacture of bronze and aluminum castings and babbitt metals.

George R. Rich, president, Rich Mfg. Co., 3851 Santa Fe avenue, Los Angeles, has arranged to transfer the Los Angeles plant to Battle Creek, Mich. A plant, 150 x 300 feet, costing $100,000 will be provided. Operations are planned for Jan. 1. The company manufactures water and steam valves.

Jenkins Bros. Ltd., 103 St. Remi street, Montreal, Que., has secured a tract of land between Rockfield and Dominion stations to which the plant will be moved. An iron foundry will be the first unit to be erected. Ross & McDonald, 601 Belmont street, are the architects.

Holmes Foundry Co., Port Huron, Mich., recently opened its plant on Second street, which has been idle since last April. Additional equipment has been purchased and, although the shop will operate at 25 per cent capacity for the present, an incerase to 50 per cent capacity is contemplated in the near future.

Falk Corp., Milwaukee, has received a $100,000 order for two ship reduction gears from the Bethlehem Shipbuilding Corp., Bethlehem, Pa. Four gears were ordered previously and the total order amounts to $350,000. The gears weigh approximately 140,000 pounds and will be installed in three freight and passenger ships for the Matson line.

Bosshardt Steel Corp., Canton, O., which has leased the plant formerly occupied by the Canton Steel Foundry Co., Canton, has started engineering work to prepare the plant for production. Operations are planned for early in 1931. The new company was incorporated by E. A. McCusky, Albert B. Arbaugh and M. F. Berberich. (Noted Nov. 1.)

Noonan-Malmstrom Co., 1845 Carroll avenue, Chicago, has purchased the good-will and foundry plant of the Monighan Foundry Co., 2135 Carroll avenue. The property includes a tract of land, 75 x 125 feet, with a two and one-half story building. The foundry business will be known as the Monighan Foundry division of the Noonan-Malmstrom Co. L. R. Noonan is president of the Noonan company, Walter K. Malmstrom, treasurer, and M. A. Malmstrom, secretary.

Link-Belt Co., 910 South Michigan avenue, Chicago, has closed a contract for improvements to its Indianapolis foundry unit. Powdered coal units are to be installed for melting and annealing furnaces. Plant improvements and a plant to house the powdered fuel system also are included in the contract. Improvements are being made at an expenditure of $125,000.

Treadwell Engineering Co., Twenty-fifth and Lenox streets, Easton, Pa., is more active than at any time in its history. Its enlarged shops are operating at 100 per cent of rated capacity and working both day and night shifts. The company recently added a new pattern storage and is installing an oil-fired heat treating furnace in its steel foundry.

The next session of the state legislature of Wisconsin, which convenes in Jan. 1931, will be asked to establish a gray iron foundry at the Wisconsin state prison, Waupun, Wis. The proposed new foundry would be used for the production of municipal, county and state needs and would make such products as manholes and covers, cast iron sewer pipe, lamp posts, hydrants, etc.

New Trade Publications

BENDING MACHINES—Bulletin No. 26 from the Wallace Supplies Mfg. Co., 1310-12 Diversey parkway, Chicago, is devoted to descriptions of the hand and power bending machines handled by the company.

AIR COMPRESSORS — General Electric Co., Schenectady, N. Y., has issued an illustrated booklet describing its centrifugal compressors. A folder accompanying the booklet is devoted to single-stage centrifugal air compressors for cupola blowing.

HEATING FURNACES — Electric Furnace Co., Salem, O., is circulating a bulletin on its oil and gas-fired continuous and batch-type billet heating, forging and car-type furnaces for heating, normalizing and heat treating. Labor-saving, material-handling equipment also is described.

CRANES — Cleveland Electrical Tramrail division, Cleveland Crane & Engineering Co., Wickliffe, O., devotes its current bulletin to its hand and electric cranes used in connection with its overhead tramrail for materials handling, with illustrations of cranes in operation.

COMPRESSORS—Yeomans Bros. Co., 1433 Dayton street, Chicago, has issued a bulletin illustrating and describing its rotary compressors and dry vacuum pumps. The advantages of the equipment are discussed and drawings showing the construction are given along with typical applications.

SPEED REDUCERS — Falk Corp., Milwaukee, has issued a 68-page catalog describing parallel shaft, herringbone-gear, speed reducers. A wide variety of the standard units made are described and ratios and capacities for general industrial applications are given. Drawings and engineering data aid in the selection of the proper unit for a given need.

DIE CASTINGS — Aluminum Company of America, Pittsburgh, has published a booklet covering its aluminum alloys for die castings. Data are given on the properties of these alloys including strength, appearance, corrosion resistance and permanence. Illustrations of typical die castings made from the company's products are given. The booklet is concluded with a section on the design of die castings.

ELECTRICAL EQUIPMENT—General Electric Co., Schenectady, N. Y., has issued a series of bulletins, and a booklet on electrical equipment for cranes. The bulletins describe quartz rod thermostat equipment for melting pots, general-purpose, squirrel-cage induction motors, direct-current crane and hoist motors and fractional-horsepower motors and parts. The booklet on crane equipment covers crane applications of the company's products.